UNITED STATES DEPARTMENT OF AGRICULTURE

DEPARTMENT BULLETIN No. 1348

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AN APPRAISAL OF POWER USED ON FARMS IN THE UNITED STATES

By

C. D. KINSMAN

Agricultural Engineer, Bureau of Public Roads

CONTENTS

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THIS BULLETIN has been prepared under the direction of the committee on farm power, appointed by the Secretary of Agriculture to represent the Bureau of Public Roads, the Bureau of Agricultural Economics, and the Bureau of Animal Industry in a cooperative study of all phases of the farm-power problem.

Agriculture in the United States uses practically as much primary power as all manufacturing and central station plants combined. The cost of using this power amounted to approximately $3,000,000,000 for the year 1924. However, by the aid of this power the average agricultural worker has been enabled to increase his volume of production nearly three times over the average of 75 years ago. Power and labor together represent on the average about 60 per cent of the total cost of carrying on the farm business, and, since these are two items directly subject to the control of the farm operator, great opportunities exist for the cutting down of production costs through a better understanding of the power requirements of farm operations, through the adoption of more efficient and less expensive types of power units, and by a more extensive use of power to replace human labor.

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INTRODUCTION

The adoption of labor-saving machinery made possible by the extensive use of power has been universally acknowledged as the outstanding feature of American agriculture during the past three-fourths of a century. Seventy-five years ago the average agricultural worker could care for but 12 acres of crops; now, considering the United States as a whole, he can attend to at least 34 acres and in some States where large power units are common the average is more than 100 acres (see Table XV), while on many individual farms it will run as high as 300 acres or more.[1] At the same time the workers' hours have been considerably shortened and much of the drudgery and monotony of farm work has been eliminated.

The increased efficiency in accomplishing farm work has greatly enhanced returns from farming and has released large numbers of workers from agriculture to other industries. This has resulted in greater production and a lower cost of comforts and luxuries, the enjoyment of which determines to a large extent the standard of

[1] Tables I to XXIV may be found in Appendix I.

living of a people. Undoubtedly these factors have played an important part in making possible the present standard of living of the people of the United States. Figure 1 shows the total acreage in crops in the United States and the total number of persons engaged in agriculture during the period from 1850 to 1920. The shaded portion represents the increased crop acreage made possible by improved methods of farming since 1850. Figure 2 shows for the same period the relation between the number of persons engaged in agriculture and the total number gainfully occupied in all employments in the United States. The shaded portion in this case represents the additional workers that would have been required to take care of the crops produced had 1850 methods of farming continued to 1920.[2]

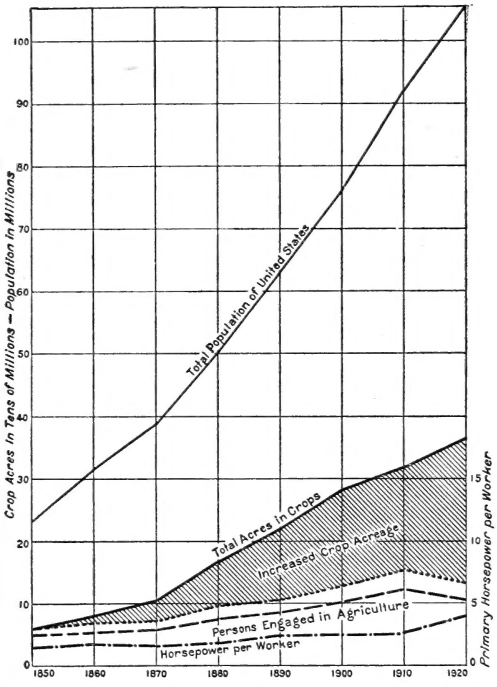

FIG. 1.—Relation between power per agricultural worker and increased crop production. The shaded portion shows the increased crop acreage due to changed conditions and improved methods of farming since 1850. Based on United States census data

The importance of farm power as a problem at the present time may be appreciated by comparing the power used in agriculture with that used in some of the other larger industries. Figure 3 shows this comparison between agriculture, the manufacturing industries, mining, and railroad transportation, based on reports of the Fourteenth Census of the United States. The total capital invested and the number of workers employed in agriculture are greater than in any of the other industries, while the primary horsepower available for use is greater than for either mining or manufacturing and is second only to that used by the railroads.

The total amount of power used annually on farms in the United States amounts to close to 16,000,000,000 horsepower-hours, while

[2] It is probable that not all of this apparent increase in production per worker can be attributed directly to increased efficiency in farming. Some operations formerly performed on the farm have been transferred to the manufacturing groups in the towns and cities as the industrial groups have been developed. However, the reduction in the length of the farmer's workday and the greater leisure the agricultural worker now enjoys largely offset any transfer of operations that has occurred. Some of the credit for the actual increase of farm efficiency is, no doubt, due also to a better understanding of the crops best adapted to the various soil and climatic conditions, to the use of better seed, and to the exercise of better management throughout; but a large part of this greater efficiency can undoubtedly be attributed directly to the displacement of hand labor by power.

the cost under 1924 conditions averages about 19 cents per horsepower-hour, or close to $3,000,000,000 for the year. The average power utilized per year per agricultural worker amounts to about 1,500 horsepower-hours, which is equivalent to about 2,500 horsepower-hours for the average farm. About 80 per cent of this power is used directly in the production and marketing of farm crops; the remaining 20 per cent is used for miscellaneous operations around the farmstead, in the house, in caring for the livestock, and for hauling other than that required directly for the crops. Figure 4 shows the approximate amount of each kind of power developed annually and the principal operations by which it is utilized.

The most serious difficulties encountered in the efficient use of power and labor in farm work are the extreme seasonal demands of many of the crops, the diversity of the operations, the small size of the usual power units, and the low load factor or small percentage of time the power unit is used. The result is a relatively high cost per unit of power produced.[3]

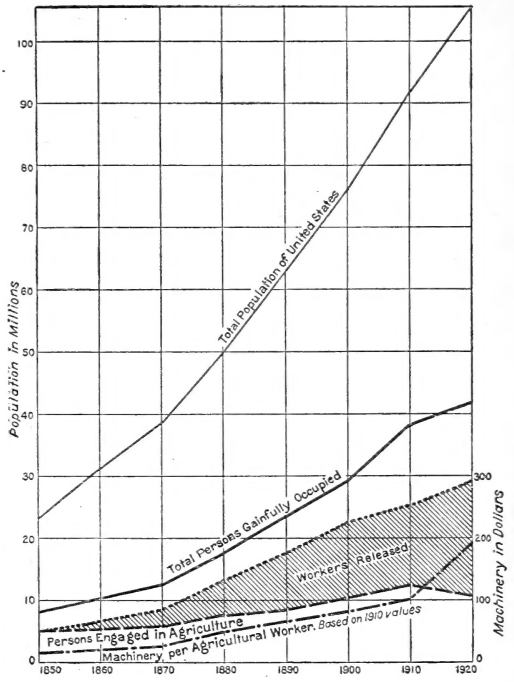

FIG. 2.—Workers released from agriculture due to improved methods and conditions on farms in United States. The shaded portion shows the additional farm workers that would have been required to produce the crops raised if the 1850 methods and conditions had continued to prevail. Based on United States census data

Most of the machinery now used in agriculture has been developed to the point were it not only saves human labor but in most cases will do the work considerably better than it can be done by hand methods. Great credit is due the manufacturers of agricultural equipment for these developments.

However, while the machines already developed accomplish the work for which they are designed, little scientific study has been devoted to the determination of the basic requirements of the operations or to ascertaining whether the methods used accomplish the results with a minimum of power input. The plow, for instance, is probably the oldest agricultural tool for which power other than human labor is used; yet the fundamental requirements of plow

[3] Agriculture has a higher investment per primary horsepower and a lower load factor than any of the other industries shown. The present load factor of agriculture is less than 4 per cent, while that of the manufacturing industries is close to 15 per cent.

design are still undetermined, and no satisfactory means of measuring the actual work done in accomplishing this operation has as yet been developed. That there exist great possibilities in the more efficient designing of farm machinery through careful study of the power requirements is suggested by the results so far accomplished in the silage-cutter tests now being conducted by the department of agricultural engineering of the University of Wisconsin, which

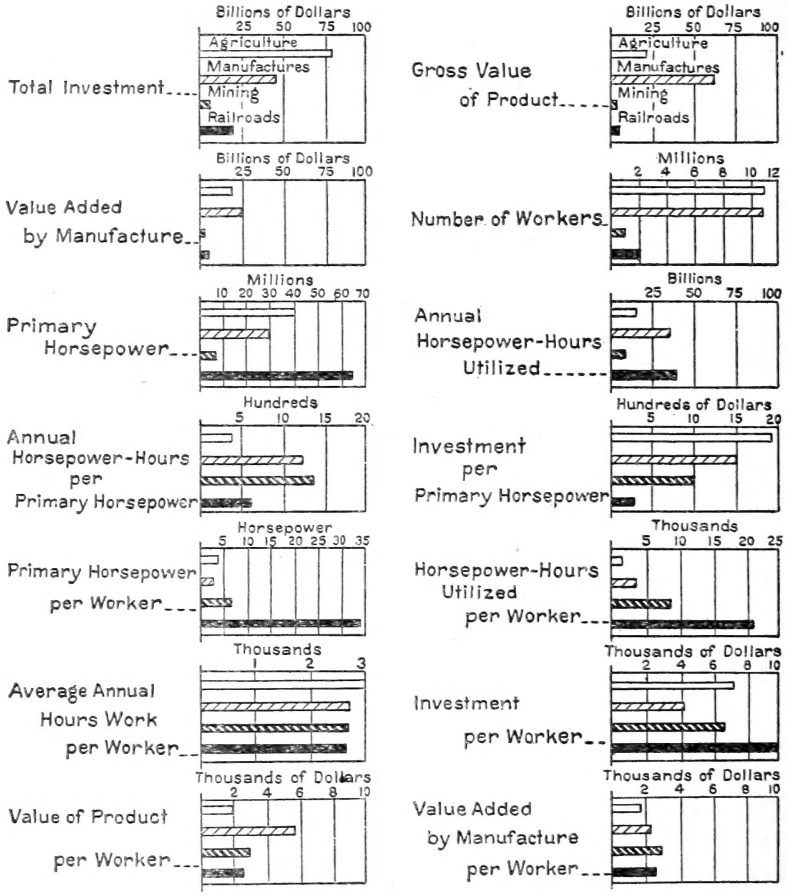

FIG. 3.—Comparison of agriculture with other industries. These values are based upon reports of the Fourteenth census of the United States, the Interstate Commerce Commission, and the Federal Power Commission

already have shown that the power necessary to cut and elevate silage may be reduced at least 50 per cent by employing proper speeds and a blower of better design.

Since power and labor represent on the average approximately 60 per cent of the total cost of producing farm products, a better understanding of the power requirements of farm operations will undoubtedly show that great opportunities exist for material reductions in production costs through the adoption of more efficient

and less expensive types of power units and by a more extensive use of power to replace expensive human labor.

This bulletin is a summary of the information now available that has to do with the use of power in agriculture, and is intended to serve as a basis for further research toward more efficient power utilization by the agricultural industry.

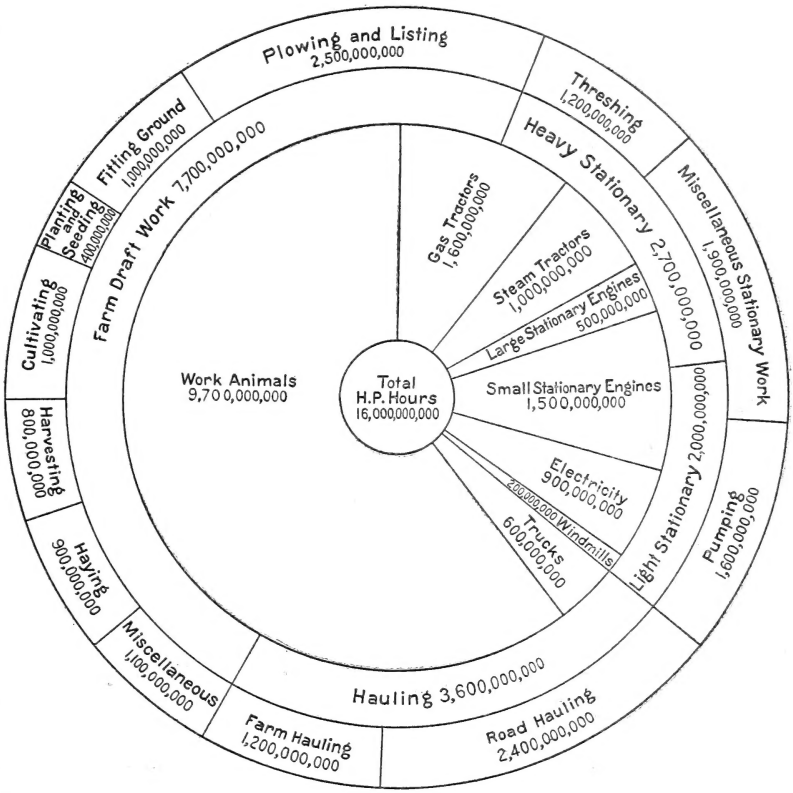

FIG. 4.—Estimated horsepower-hours of power developed annually by different kinds of power used on farms and the amounts required for the principal farm operations in the United States

SOURCES OF INFORMATION

Material from all sources available has been drawn upon freely. A selected bibliography of the publications used is given in Appendix II. In addition much valuable material was obtained directly from the Bureau of Agricultural Economics, United States Department of Agriculture, the various State colleges and State agricultural statisticians, the Federal Power Commission, the Interstate Commerce Commission, manufacturers of agricultural equipment, farm publications, and individuals interested in the farm-power problems. Where material is quoted directly credit has been given; but in many cases where tables have been based upon information obtained from

a number of sources it has not always been practicable to name each individual source.

Much of the statistical information presented is based on data obtained from publications of the Bureau of the Census, United States Department of Commerce, and the Bureau of Agricultural Economics, United States Department of Agriculture. Such statistics may be considered as fairly accurate; but the figures for the power requirements of farm operations, those representing the production of various farm commodities, and those for the total amount of power utilized have been based on rather limited data and must be considered as only approximately correct, since so many factors enter into their determination that much more experimental information

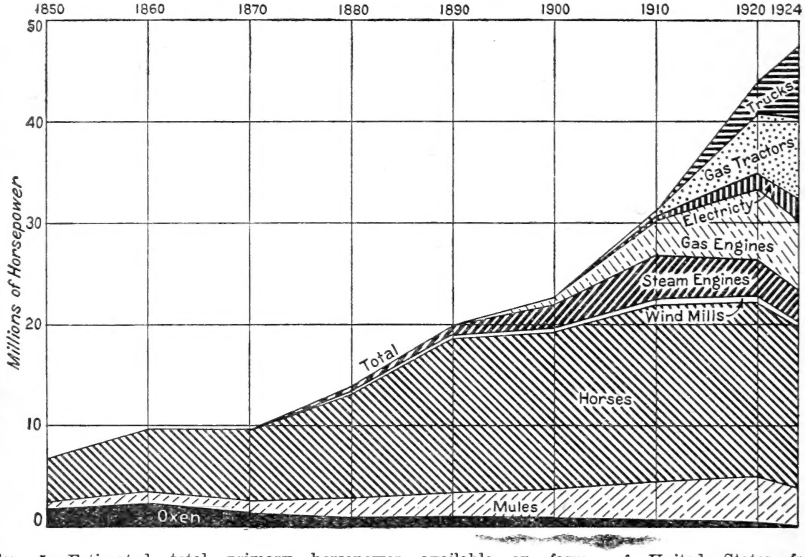

FIG. 5.—Estimated total primary horsepower available on farms of United States from 1850 to 1924 inclusive

will be necessary before they can be determined accurately for all conditions. The immediate need for information of this kind, however, in order to give some comprehension of the nature of the farm-power problem, justifies the publication of the available data.

SOURCES OF POWER USED ON FARMS

The sources of power now available on farms in the United States in addition to human labor are animals, gas engines (including tractors, trucks, and automobiles), steam engines, and electric, wind, and water motors.

The power of animals was the earliest form of power to be utilized by man, and up to about 60 years ago this source afforded practically the only power used by agriculture in the United States. Wind had been used to some extent, but the areas where windmills are most efficient were not settled before 1860; stationary steam en-

gines were employed for operating threshing machines and other heavy belt work soon after the Civil War; and the gas engine came into successful use about the beginning of the twentieth century. From that time there has been a continuous and rapid development in the use of mechanical power in agriculture. Tractors were first used for draft work when a demand developed for large power units for grain farming in the West. Steam tractors were first used for this purpose but soon were displaced by the more practical gas tractors.

The small gas tractor, the truck, the automobile,[4] and the use of electric power have been of more recent development and have only become important factors in agriculture during the last 10 or 12 years. Figure 5 shows the approximate amount of each kind of power available on farms from 1850 to 1924.

ANNUAL USE AND COST OF POWER ON FARMS IN THE UNITED STATES

The tables on page 8 summarize the power available on farms in the United States, and give an estimate of the amount and cost of the power developed annually, together with the principal operations through which it was utilized under 1924 conditions.

Approximately 16,000,000,000 horsepower-hours are utilized annually at the present time. Of this amount animal power furnishes about 61 per cent, tractors 16 per cent, motor trucks slightly less than 4 per cent, stationary engines 12½ per cent, windmills slightly over 1 per cent, and electric power 5½ per cent.

Of the power developed, about 48 per cent is utilized for field work, 15 per cent for road hauling, 7 per cent for hauling about the farm,[5] 17 per cent for heavy stationary work, and 13 per cent for light stationary work. (Heavy stationary work is considered as all operations requiring more than 5 horsepower.)

Plowing and listing, grouped together, rank highest of all farm operations in the amount of power utilized, with a total of approximately 22 per cent of the draft work or almost 16 per cent of the total power used; road hauling ranks only slightly lower; threshing stands highest in the stationary operations, requiring over 25 per cent of all the stationary power utilized; and pumping for irrigation and drainage rank next, using over 20 per cent of this type of power.

[4] The automobile as a source of power on farms has not been considered in this bulletin, as only a small part of the power developed by this means is used to do actual farm work. Surveys that have been made would indicate that at least 80 per cent of the use the farmer makes of the automobile is in the care and supervision of his business.

[5] See Tables XXII and XXIII for tonnage of farm and road hauling and the average length of haul.

Approximate power units, primary horsepower, horsepower-hours, and cost of power utilized annually on farms in the United States

Kind of power	Total units or installations	Average primary horsepower per unit	Total primary horsepower		Average horsepower-hours per primary horsepower per year	Total horsepower-hours utilized annually		Average cost per horsepower-hour [1]	Total annual cost of power developed	
	Thousands		*Thousands*	*Per cent*		*Millions*	*Per cent*		*Million dollars*	*Per cent*
Work animals	20,770	[2] .95	19,800	41.8	490	9,700	60.6	0.25	2,425	80.8
Gas tractors:										
Belt	400	20	8,000	16.9	88	700	4.4	.06	42	1.4
Drawbar	----	10	[3] 4,000	----	225	900	5.6	.125	112	3.7
Steam tractors	50	50	2,500	5.3	400	1,000	6.4	.06	60	2.0
Motor trucks	356	20	7,120	15.0	80	600	3.7	.20	120	4.0
Stationary engines:										
Large	20	25	500	1.0	1,000	500	3.1	.04	20	.7
Small	2,480	2.75	6,800	14.4	220	1,500	9.4	.08	120	4.0
Windmills	1,000	.5	500	1.0	400	200	1.3	.05	10	.3
Electric power:										
Individual plants	300	3	900	1.9	[4] 167	[4] 150	.9	[5] .25	38	1.3
Central station, small	200	4	800	1.7	190	150	.9	[5] .15	23	.8
Central station, large	20	25	500	1.0	1,200	600	3.7	[5] .05	30	1.0
Total	----	----	47,420	100.0	320	16,000	100.0	.19	3,000	100.0

[1] Based on 1924 average values and includes interest, depreciation, taxes, insurance, housing, repairs, feed, fuel, oil, and care when not in use but does not include wages of operator while in actual use. The values computed for the different kinds of power are not directly comparable, since the nature of the work done and the load factors obtained are not identical in each case.

[2] The power of a 1,200-pound horse or mule has been considered as equal to 1 primary horsepower, and the power of larger or smaller work animals has been computed on the assumption that it is proportional to their weight.

[3] Gas-tractor drawbar power is included under belt power in the total.

[4] Represents input, not output.

[5] Rate based on power input, not on output.

Estimated utilization of power developed on farms annually, by operations and nature of work accomplished

Type of operation	Estimated power utilized annually	Percentage of each type	Percentage of total
	Thousand horsepower-hours	*Per cent*	*Per cent*
Draft work:			
Road hauling	2,400,000	21.2	15.0
Farm hauling	1,200,000	10.6	7.5
Plowing and listing	2,500,000	22.1	15.6
Fitting ground	1,000,000	8.9	6.3
Planting and seeding	400,000	3.5	2.5
Cultivating	1,000,000	8.9	6.3
Harvesting	800,000	7.1	5.0
Haying	900,000	8.0	5.6
Miscellaneous field work	1,100,000	9.7	6.8
Total draft work	11,300,000	100.0	70.6
Stationary work:			
Threshing	1,200,000	25.5	7.5
Pumping (irrigation and drainage)	1,000,000	21.3	6.3
Pumping (domestic)	600,000	12.8	3.7
Operating isolated electric plants	150,000	3.2	1.0
Grinding feed	200,000	4.3	1.3
Baling hay	100,000	2.1	.6
Shredding feed	100,000	2.1	.6
Sawing	100,000	2.1	.6
Shelling corn	80,000	1.7	.5
Cutting silage	50,000	1.1	.3
Miscellaneous	1,120,000	23.8	7.0
Total stationary work	4,700,000	100.0	29.4
Total, all farm operations	16,000,000	----	100.0

A large number of operations come under the "Miscellaneous" headings and the information available does not justify any estimate of the amount of power used by each. Of those not listed the principal draft operations are ditching, land leveling, and grading; and the miscellaneous stationary work consists principally of the operation of stone crushers, cane mills, cotton gins, spraying machinery, milking machines, cream separators, churns, grain elevators, seed cleaners and graders, hay hoists, tool grinders, washing machines, and household appliances.

NUMBER OF POWER UNITS OR INSTALLATIONS ON FARMS AND NUMBER OF WORKERS ENGAGED IN AGRICULTURE

In Table I of the Appendix is given an estimate of the number of horses, mules, trucks, tractors, stationary engines, and electrical installations by States, available on farms January 1, 1924, and the number of agricultural workers as reported by the Fourteenth

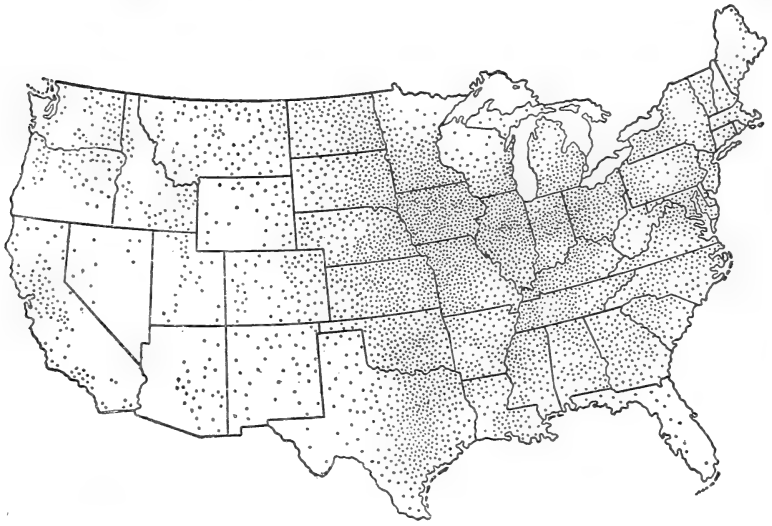

FIG. 6.—Estimated distribution of work animals on farms in 1924. Each dot represents 5,000 animals. Based on reports of the Bureau of the Census corrected according to estimates from the Division of Crop Estimates, Bureau of Agricultural Economics, Department of Agriculture

Census. The distribution of work animals and tractors is shown in Figures 6 and 7.

The estimated total number of power units now available on farms in the United States is as follows:

Oxen	200, 000	Stationary engines	2, 500, 000
Horses	15, 916, 000	Electric installations	500, 000
Mules	4, 654, 000	Windmills	1, 000, 000
Tractors	450, 000	Automobiles on farms	4, 500, 000
Trucks	356, 000		

Some water power is used in certain areas, but the total amount is insignificant compared with the total of all kinds of power. The windmills are used mainly in the Central West and in some places along the sea coast where the average wind velocity is sufficient to justify their use.

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PRIMARY POWER AVAILABLE AND HORSEPOWER-HOURS UTILIZED ANNUALLY ON FARMS[6]

Table II shows the estimated total primary horsepower available and Table III the horsepower-hours developed annually on farms by States. Data for horses, mules, tractors, and trucks have been worked out separately, but it has been necessary to base the figures for stationary power largely on the power required to do the work rather than on the amount of each kind of power developed, and for this reason stationary engines, windmills, and electric power have been grouped together.

The figures for animal power are based on information contained in Table XXI. One 1,200-pound animal has been assumed to be capable of developing 1 primary horsepower. This rating is perhaps somewhat higher than it has been customary to use; but it is known that many horses of this weight develop a full horsepower

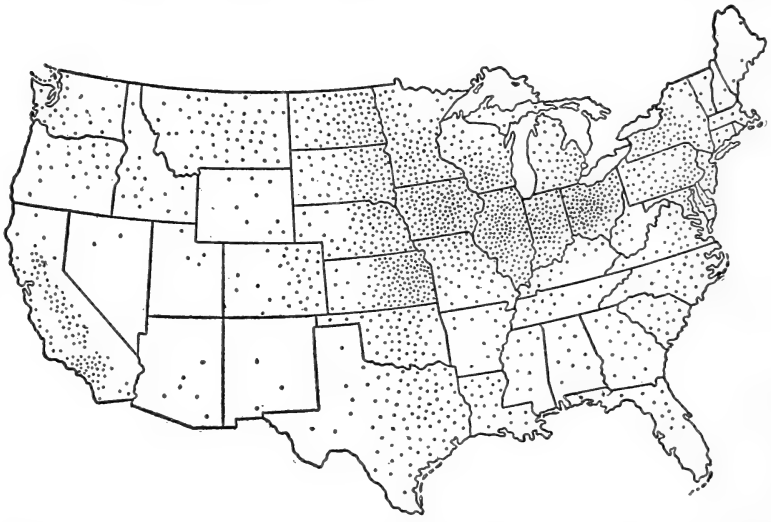


FIG. 7.—Estimated distribution of tractors on farms in 1924. Each dot represents 250 tractors

for a considerable period of time when doing heavy work, such as plowing, and in view of the results of recent tests with the Iowa horse dynamometer this figure is considered to be a reasonable basis for estimating the available primary power. The data for horsepower-hours per average work animal, given in Table XXI, were compiled from a large amount of information made available by

[6] The most common unit used in the United States for measuring work is the foot-pound. This represents the work done in lifting to a height of 1 foot a body weighing 1 pound, or moving an object 1 foot against a resistance of 1 pound. Power is the rate of doing work, and the usual unit for measuring power is the horsepower, which is equivalent to the power required to perform work at the rate of 33,000 foot-pounds per minute. (See Table XXIV of the Appendix for pounds pull exerted per horsepower at different rates of travel.) By primary power is meant the maximum load any power unit or series of units is capable of developing for a reasonable length of time. Some kinds of power, such as animal power, and most steam engines, have a considerable reserve capacity in addition to this that can be exerted for very short intervals. A horsepower-hour is equal to 1,980,000 foot-pounds (33,000×60), and is the most common unit used when determining quantity of work done or power developed. (See Tables III and V and page 8 for quantity of power developed and amount required for various farm operations.)

farm-management studies, due allowance being made for the kinds of soil and types of farming followed and the average weight of work animals in the different States. The figures for the power developed by tractors, trucks, and stationary units were also compiled largely from information available in farm-management studies, together with data obtained from agricultural engineering departments of State colleges, manufacturers, the Bureau of the Census, and other scattered sources.

The relative amount of power utilized varies greatly in the different States. This variation is caused partly by differences in the

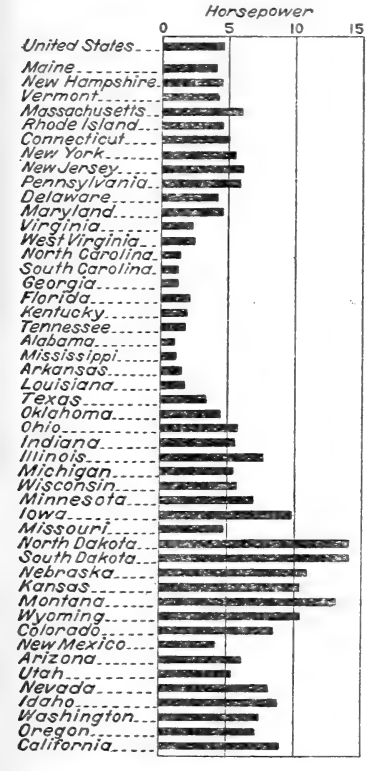


FIG. 8.—Average primary horsepower per farm worker

FIG. 9.—Average primary horsepower per farm

kind of crops raised, but is also largely the result of the prevailing size of farms, types of soil, climatic conditions, and usual wages paid farm labor.

The primary power per worker and per farm and the horsepower-hours utilized annually per worker, per farm, per improved acre, and per hour of human labor, have been computed from Tables II and III, and are shown in Table IV. These amounts are shown graphically in Figures 8 to 11 and 13 to 16. The primary power varies from as low as 1 horsepower per worker and 2 horsepower per farm in Alabama, to as high as 14.1 per worker and 22 per farm in South Dakota, while the horsepower-hours utilized vary from 380 per

worker and 730 per farm in Alabama, to as high as 4,580 per worker in North Dakota and 10,000 per farm in California.

Farm-management studies and the various surveys made indicate that the average agricultural worker is employed in productive labor

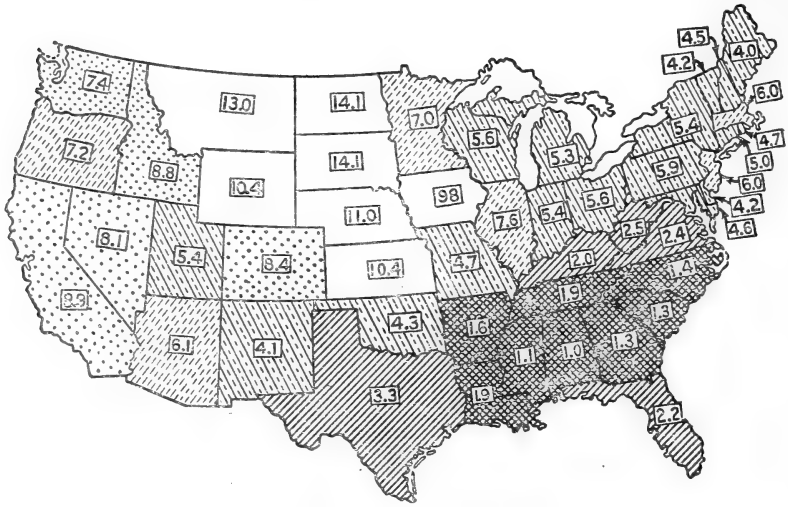


FIG. 10.—Average primary horsepower per farm worker

approximately 3,000 hours annually. From this it will be seen that, in the United States as a whole, approximately 1 horsepower-hour of power is utilized for each 2 hours of human labor. This amount

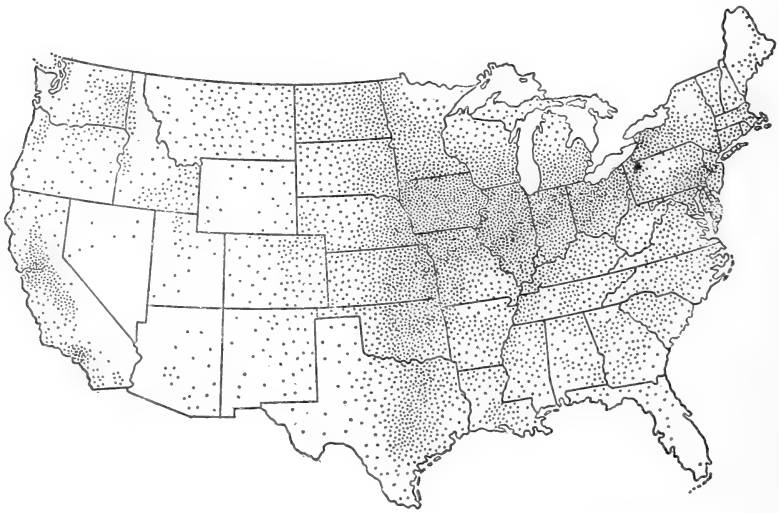


FIG. 11.—Estimated distribution of horsepower-hours of power utilized annually on farms. Each dot represents 3,000,000 horsepower-hours

varies, however, from an average as low as one-eighth horsepower-hour of power per hour of human labor in Alabama, to as high as 1½ horsepower-hours per hour of labor in North Dakota. Figure

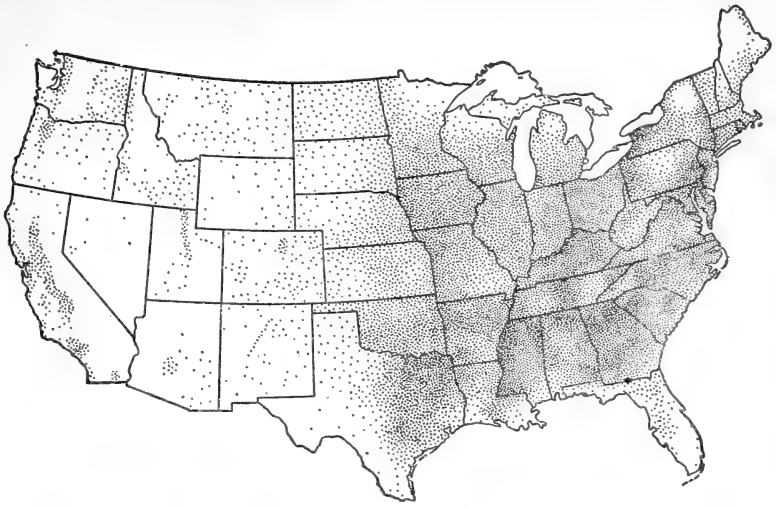


FIG. 12.—Estimated distribution of hours of human labor utilized annually on farms. Each dot represents 3,000,000 hours

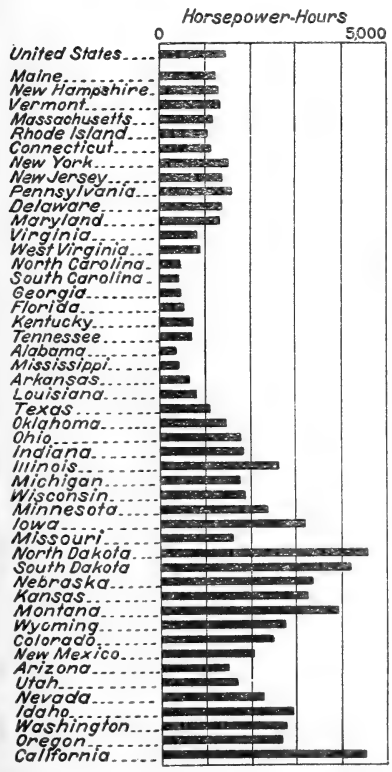


FIG. 13.—Average horsepower-hours utilized annually per farm worker

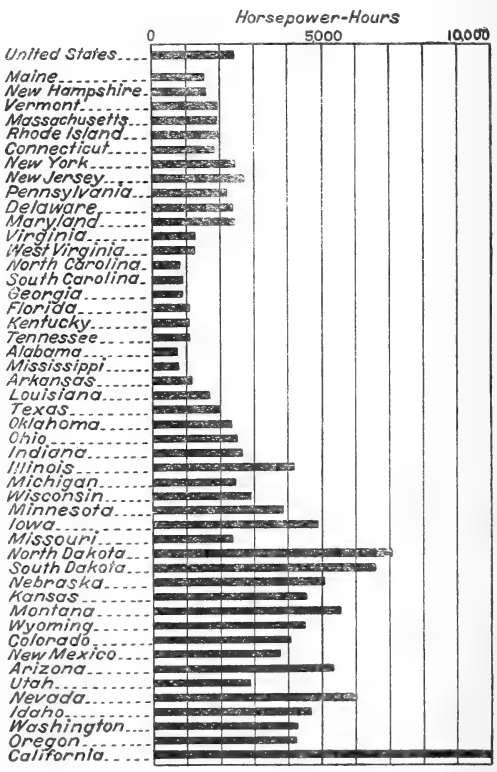


FIG. 14.—Average horsepower-hours per farm per year

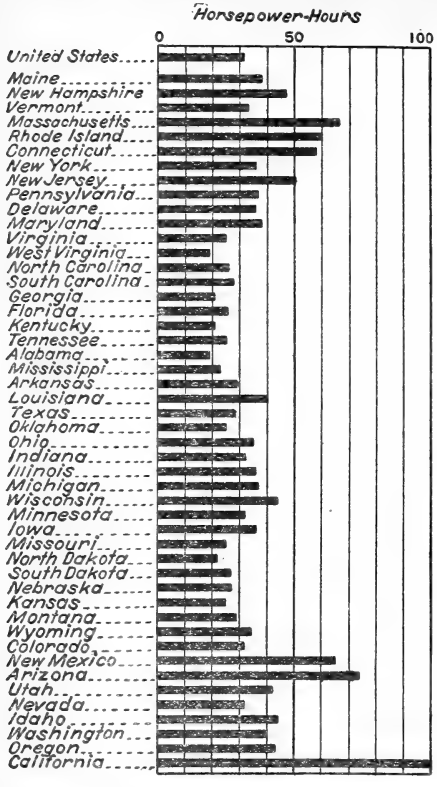


FIG. 15.—Average horsepower-hours per improved acre per year

12 shows the approximate distribution of hours of human labor utilized annually.

The figures for horsepower-hours per improved acre have been given for convenience in estimating the amount of power utilized on different sizes of farms, as this unit appears to be the one most suitable to use for this purpose. The approximate power used on any size of farm can be obtained by multiplying the number of improved acres in the farm by the average horsepower-hours utilized per improved acre.

EFFECT OF THE USE OF POWER AND MACHINERY ON PRODUCTION AND INCOME

Those areas which make a greater use of power and machinery usually show a correspondingly greater volume of production per worker. Figure 17 shows, by States, the relation existing between investment in machinery per worker as of January 1,1920, and the average value of crops produced in the

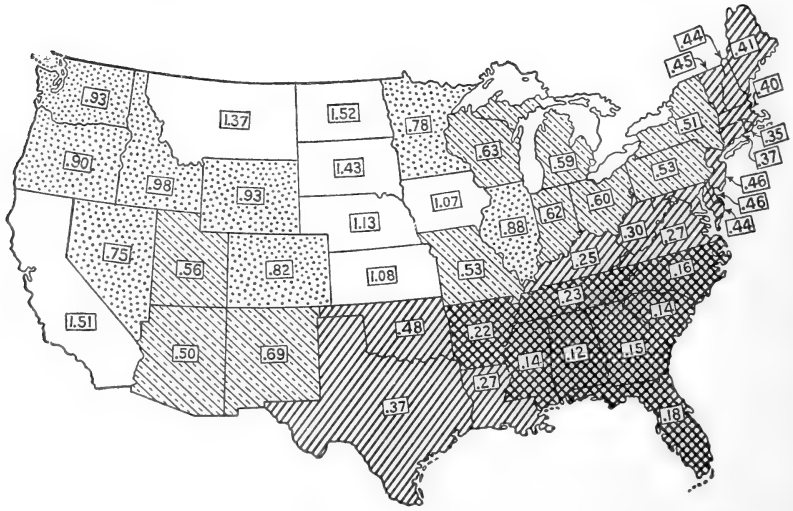


FIG. 16.—Average horsepower-hours of power utilized per hour of human labor on farms

five-year period 1919 to 1923, inclusive; Figure 18 shows the relation between the primary horsepower per worker and the value of crops for the same period; and Figure 19 shows the relation between the number of horses per worker and the volume of crop production in a number of European countries and representative States under prewar conditions.[7]

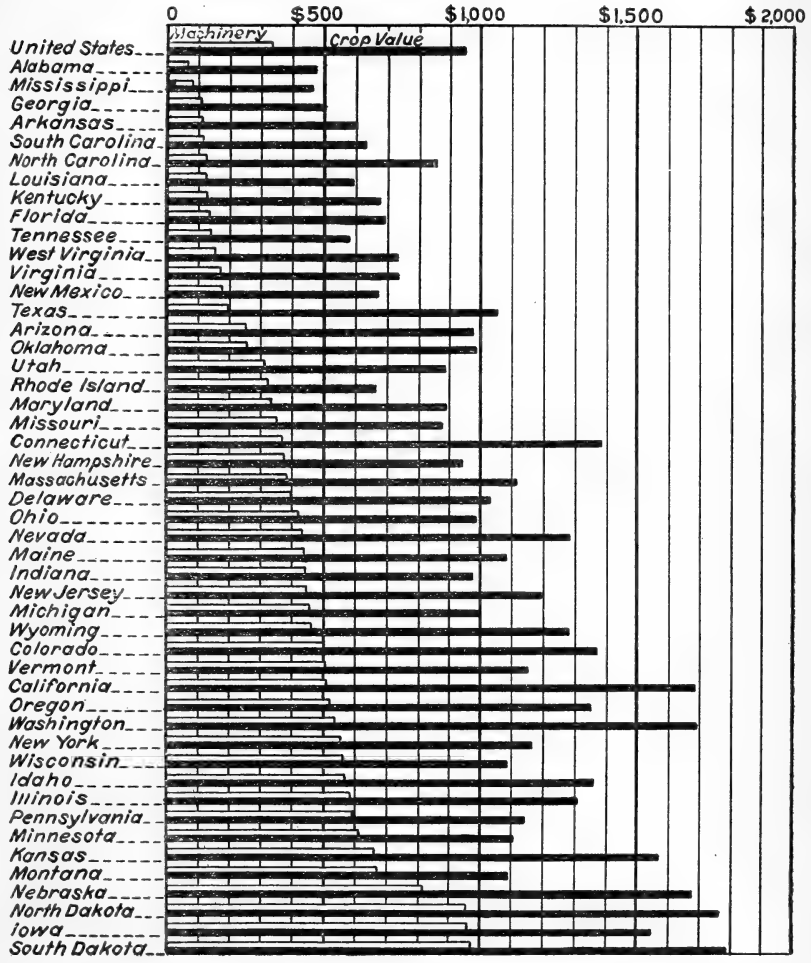


FIG. 17.—Relation between machinery available and value of crops produced per worker. Machinery, 1920 census. Crop value, Department of Agriculture average 1919–1923.

The cost of using power equipment is also considerable, and its adoption becomes profitable only if the net earnings of the owner or

[7] Horses or their equivalent animal power only are used for comparison in this case because information with regard to the mechanical power per worker for European countries is not available. In Italy cattle, buffaloes, burros, and even dogs are used as draft animals, and in Hungary and France cattle represent a considerable part of the power equipment. In making the computation five cattle, buffaloes, or burros were considered as the equal of two horses.

operator are increased through its use. Figure 20 shows for the year 1919 a comparison of the average net income per farm operator by States with the horsepower-hours of power utilized per hour of human labor. Data with respect to income of farmers by States are

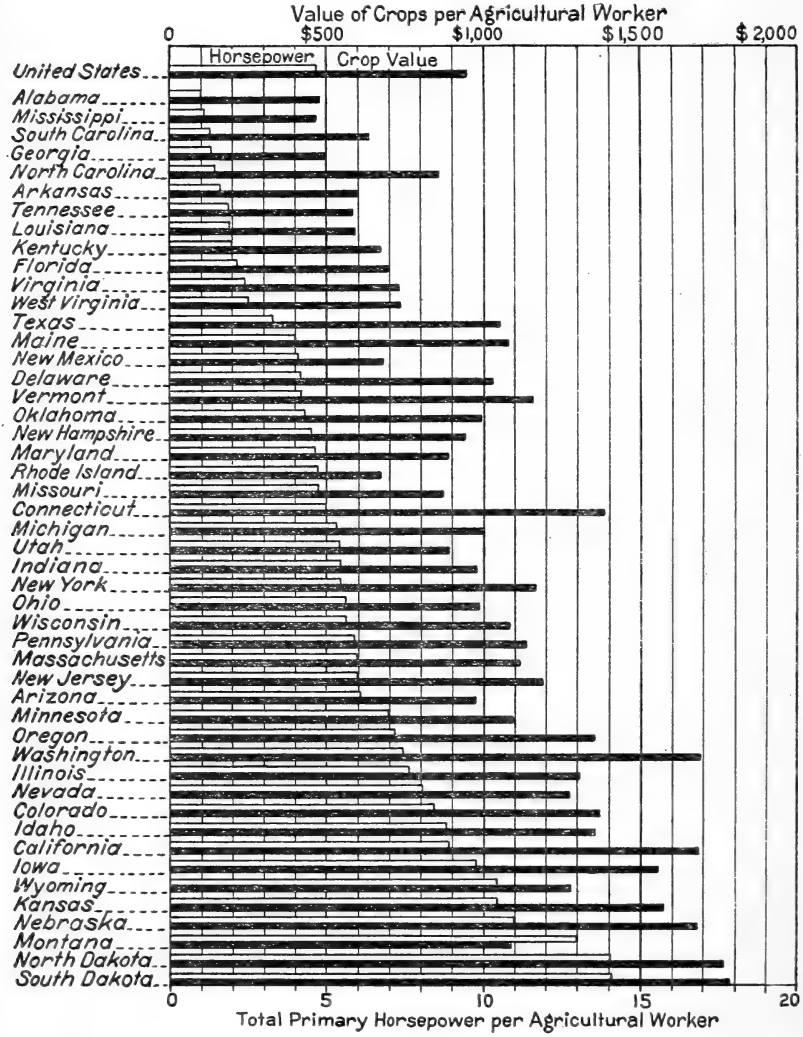


FIG. 18.—Relation between primary horsepower and value of crops produced per worker. Crop value 1919–1923 average

available for the year 1919 only, and as seasonal conditions no doubt affect the income of farmers very materially, some discrepancies are unavoidable when incomes for only one year are used;[8] but in gen-

[8] Conditions in 1919 were not normal, as Montana, Wyoming, and the Dakotas were particularly unfortunate in having very poor crop yields, which accounts, at least partly, for their poor showing in these graphs, whereas the very high price of cotton in 1919 probably gives the income of farmers in the cotton-growing States a relatively higher net value than would have occurred under normal conditions.

eral the farm operators in the States showing a high utilization of power per worker are shown to have a correspondingly high net income. This circumstance would indicate that the extensive use of power and labor-saving equipment, if effectively employed, is extremely profitable.

POWER AND LABOR REQUIREMENTS OF FARM OPERATIONS

In Tables V and VI the more general operations performed on farms are listed, together with the approximate amounts of power required for their performance as based upon the best information now available. Farm operations vary so greatly in the different parts of the United States with respect to their method of accomplishment and the information available is so limited that it has

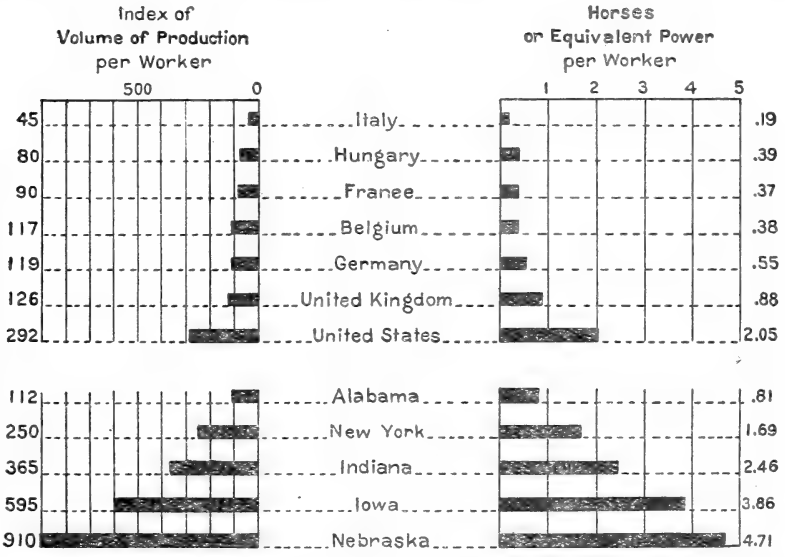


FIG. 19.—Relation between power used for field work and crop production per agricultural worker as determined by pre-war conditions. (U. S. Dept. of Agriculture 1918 Yearbook.) The average weighted index figure for volume of production per worker for all countries shown is 100, and the average number of horses or equivalent power per worker is 0.77

been impossible to go into more detail or to attempt to make a complete list of all operations performed on farms. The data as given should be considered only as a general guide when used in estimating the amount of power required under any local condition.

Since such a large proportion of the farm costs is represented by power and labor and since they are the only important items over which the farmer can exercise much control, great opportunities exist for the cutting down of production costs through reductions in the labor requirements of each operation and through a more efficient selection and application of the power used. Very little progress can be made along this line, however, until a thorough study has been made and the basic requirements of each operation have been determined.

68326°—26——3

Many local factors affect the power requirements of farm operations, and these must be given consideration in estimating the power requirements for any specific condition. Some of these factors are climate, type and condition of soil, depth of the operation, condition of the crop or commodity the operation is applied to, size of fields, size and type of power units used, mechanical efficiency of the tools

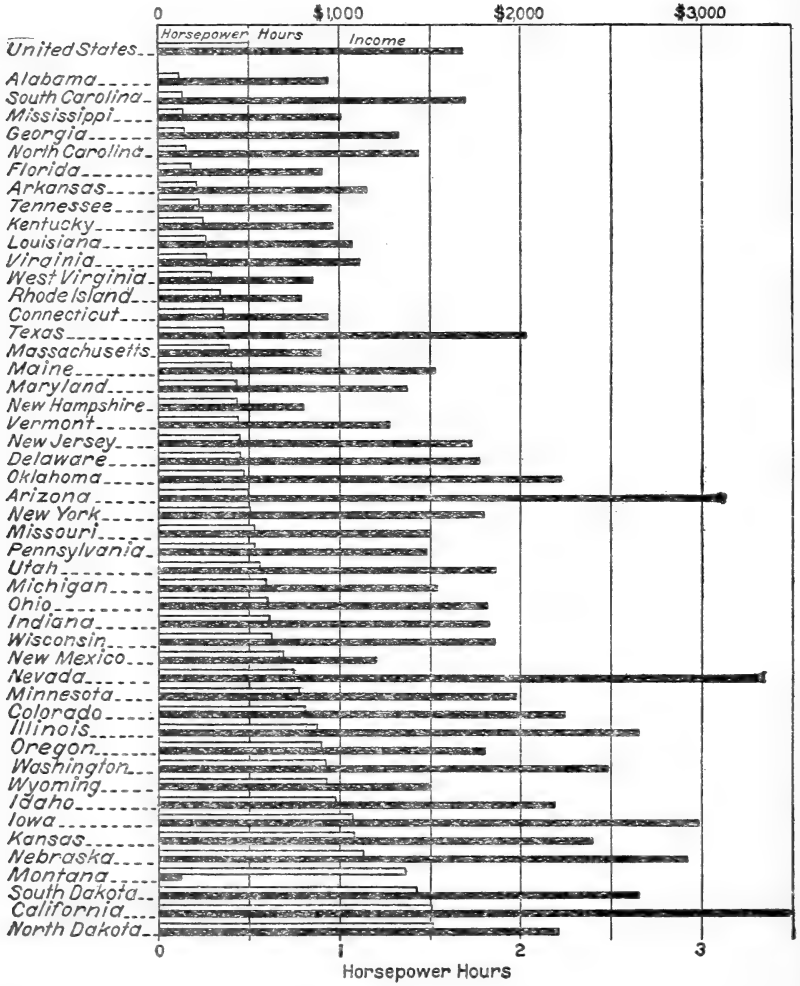


FIG. 20.—Relation between horsepower-hours of power utilized per hour of human labor on farms and net income per farm operator for the year 1910. Horsepower-hours estimated. Income from National Bureau of Economic Research

or machines used, and the local practices followed in carrying out each particular part of an operation.

The time required for accomplishing a farm operation will depend upon the size of the machinery or implement used, the speed with which it works, and the time lost while not actually working. In field work the lost time is due to time required for turning at

corners, for resting the work animals when this type of power is used, and for making repairs and adjustments when necessary to the machinery or equipment used.

Table VII gives a summary of the work factors or time required for performing field work. The time required for performing the majority of farm operations with power units of different size and under various conditions is shown in detail in the 1922 Yearbook of the United States Department of Agriculture, under the title of "Farm Operations," and also in Yearbook Separate No. 890.

POWER AND LABOR REQUIREMENTS OF FARM COMMODITIES

The amount of power and labor required in the production of any farm commodity obviously depends upon the requirements of the different operations performed. For this reason an even greater variation exists when considering the requirements of commodities than in the case of the individual operations, and any figures given should be taken as no more than a rough approximation when considered in respect to any particular case.

As a matter of general interest rather than as a guide in considering specific conditions, Tables VIII and IX have been prepared, showing the approximate average number of man-hours and horsepower-hours required for the production of the principal crops produced in various parts of the United States; Table X shows the approximate average labor and power requirements for the care of livestock. A more complete discussion of such requirements of field crops may be found in United States Department of Agriculture Bulletin 1000, Labor and Material Requirements of Field Crops.

Table XI gives, by States, the acreage of the principal crops grown in 1922, as reported by the division of crop and livestock estimates, Bureau of Agricultural Economics, United States Department of Agriculture; Table XII gives the average yield of the principal crops for the years 1918 to 1922; and Table XIII the number of each of the principal kinds of livestock kept on farms, as reported January 1, 1920, by the Bureau of the Census.[9]

DISTRIBUTION OF FARMS AND FARM LANDS AND TYPES AND SIZES OF FARMS

The types of farming followed and the sizes of farms vary considerably in different sections of the United States and even in individual communities in the same section. The most common type of farming followed in any given locality usually depends upon a number of factors, chief among which are geographical location with respect to nearness to consuming centers and the transportation facilities available, the length of the growing season and the amount and dependability of the rainfall, type and fertility of the soil, and the topography. Table XIV gives the total population, the farm population, the number of agricultural workers, the number of farms, the total land area, and the land in farms by States, based on the 1920 census. Table XV gives the average crop-acres and

[9] The distribution of each of the various crops and kinds of livestock is shown graphically in the 1921 Yearbook of the United States Department of Agriculture and in Yearbook Separate 878, "A Graphic Summary of American Agriculture."

workers per farm, the average crop-acres and value of crops per worker, the average value of all crops per crop-acre, the average value of machinery per farm and per worker, and the average net income per farm operator by States, and Figures 21 to 26 the distribution of farms, land in crops, the principal soil regions, the average length of growing season, the average annual precipitation, and the principal agricultural regions of the United States. Figure 27 shows graphically the relative importance of each of the principal crops grown in each State, and Table XVI and Figures 28 and 29 the distribution of different sizes of farms in the various States.

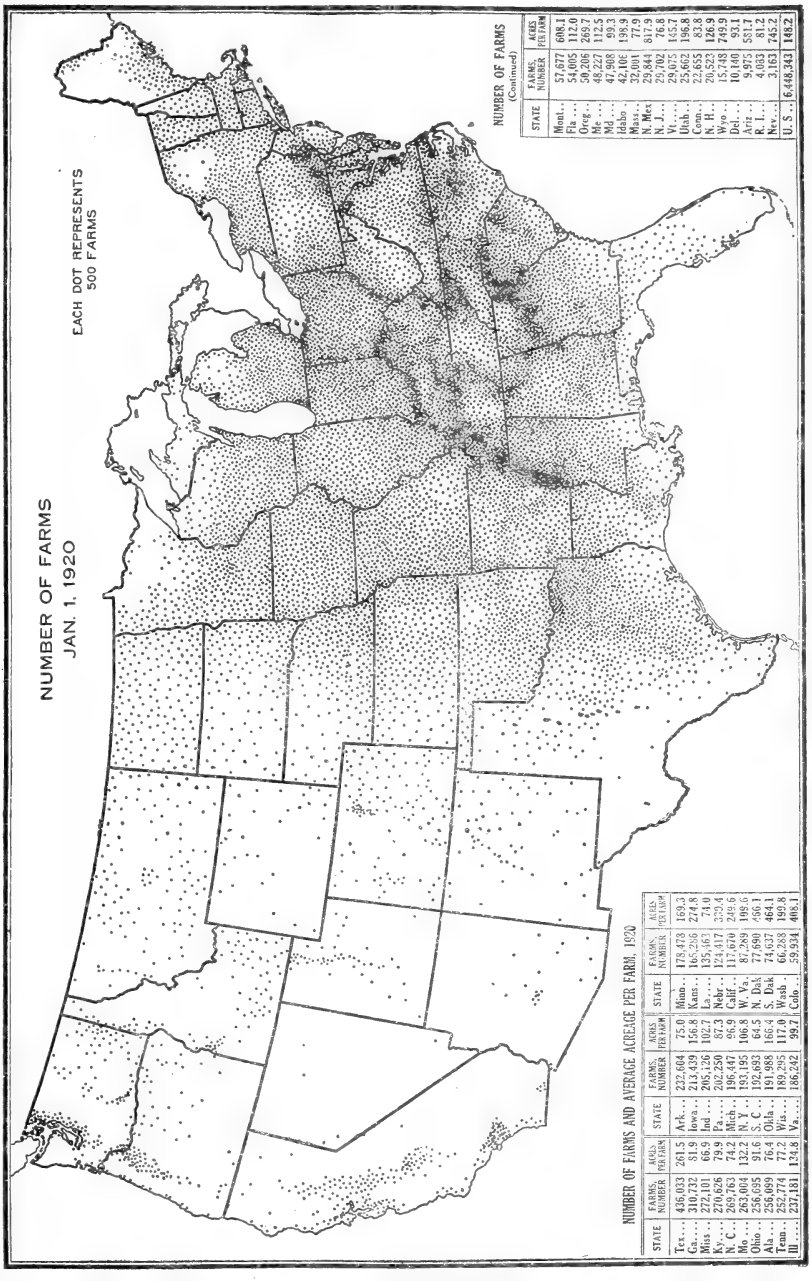
Topography, as a rule, has more to do with the average size of farms and fields predominating in any given area than any other factor. In the Central West the land generally lies fairly smooth, with few streams or ravines to cut up the fields. This condition encourages the laying out of large fields and the use of large machines or power units, with the result that fairly large farms predominate in this area. On the other hand, in the Eastern and Southern States the land is usually cut up with many hills, ravines, and streams, making small and irregular fields necessary, which discourages the use of large machines or power units, and results in a predominance of relatively small farms. (See fig. 28.) Types of crops produced also have much to do with the size of farm in a given area. Where crops are produced which require a relatively large amount of labor or power and have a high value per acre the farms usually average smaller than in areas where the crops produced require a relatively small amount of labor or power.

SEASONAL DISTRIBUTION OF THE USE OF LABOR AND POWER ON FARMS

It is extremely difficult to obtain definite information on the relative labor and power requirements of the different types of farming on account of the great variations that exist. Table XVII, however, shows the percentage of man and horse labor devoted to the different farm enterprises, and Figures 30 to 36 the distribution of labor for several types of farming as determined by a number of farm-management surveys.[10]

Probably the most serious difficulty encountered in the efficient use of power and labor in agriculture is the extreme seasonal demands of many farm operations. In each type of farming followed there is usually some single operation which requires a large amount of power to complete the work within the seasonal limits permissible, and it is usually this operation that determines the minimum amount of primary power that must be kept on any particular farm. In the Corn and Cotton Belts this operation is usually that of planting or cultivating; where hay is an important crop the harvesting of the hay is usually the determining operation, and in the small-grain regions it is sometimes the preparation of the seed bed, and in other cases that of harvesting or threshing. (See figs. 37 to 47 for examples of the distribution requirements of man and horse labor for the principal crops and livestock produced on farms in the United States.)

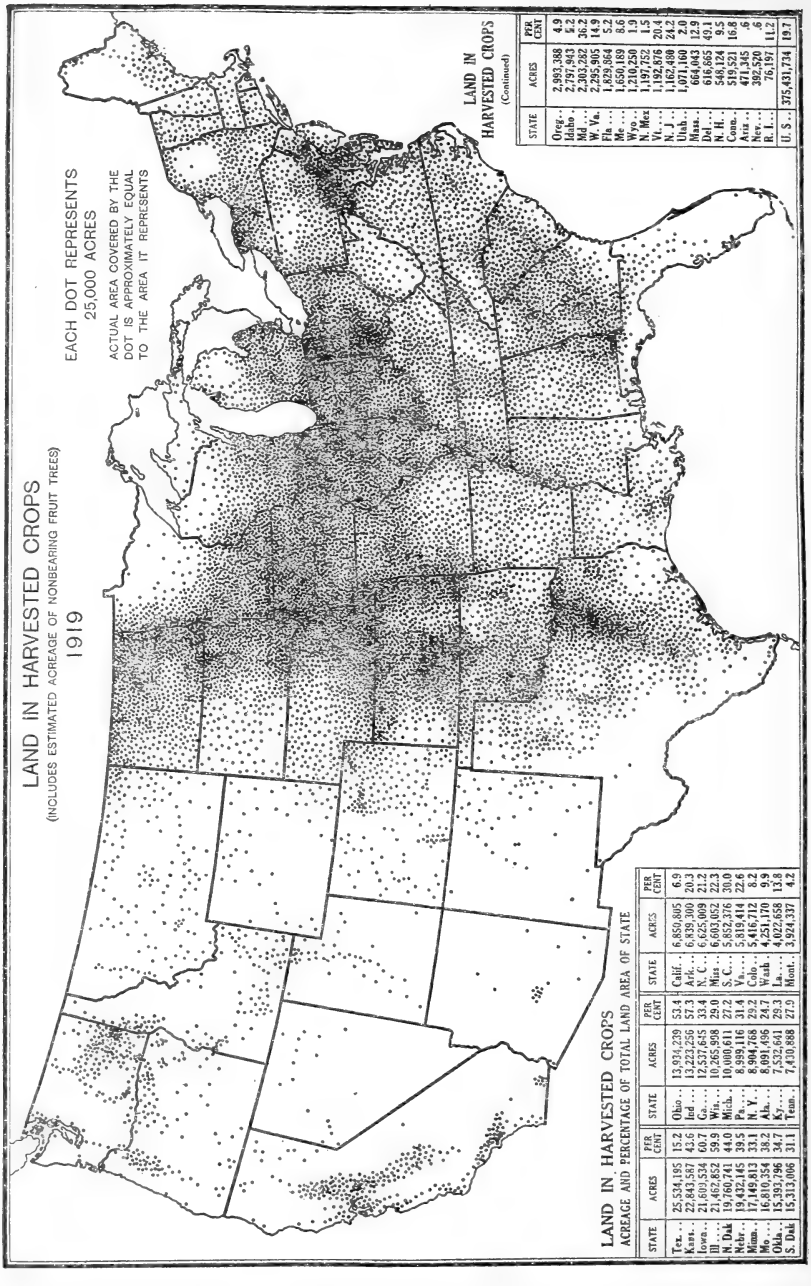
[10] A more complete discussion of types of farming and the distribution of labor on farms may be found in Farmers' Bulletin 1289 and U. S. Department of Agriculture Bulletins 814, 961, 1000, 1020, 1181, and 1271.



STATE	FARMS, NUMBER	ACRES PER FARM	STATE	FARMS, NUMBER	ACRES PER FARM	STATE	FARMS, NUMBER	ACRES PER FARM
Tex.	436,033	261.5	Ark.	232,604	75.0	Minn.	178,473	169.3
Ga.	310,732	81.9	Iowa	213,439	156.8	Kans.	165,256	274.8
Miss.	272,101	66.9	Ind.	205,126	102.7	La.	135,461	74.0
Ky.	270,626	79.9	Pa.	202,250	87.3	Nebr.	124,417	320.4
N. C.	269,763	74.2	Mich.	196,447	96.9	Calif.	117,670	249.6
Mo.	263,004	132.2	N. Y.	193,195	106.8	W. Va.	87,789	99.6
Ohio	256,695	91.6	S. C.	192,683	64.5	N. Dak.	77,690	456.1
Ala.	256,099	76.4	Okla.	191,988	160.4	S. Dak.	74,637	464.1
Tenn.	252,774	77.2	Wis.	189,295	114.0	Wash.	66,283	193.8
Ill.	237,181	124.8	Va.	186,242	99.1	Colo.	59,934	406.1

STATE	FARMS, NUMBER	ACRES PER FARM
Mont.	57,677	608.1
Fla.	54,005	112.0
Oreg.	50,206	249.7
Nev.	4,727	172.5
Md.	47,595	99.3
Idaho	42,106	138.9
Mass.	32,011	77.9
N. Mex	29,844	817.9
N. J.	29,702	76.8
Vt.	29,675	145.7
Utah	25,862	196.8
Conn.	22,653	83.8
R. I.	15,748	79.9
Wyo.	15,243	1,249.9
Del.	10,140	93.1
Ariz.	9,975	581.7
R. I.	4,033	81.2
Nev.	3,163	245.2
U. S.	6,448,343	148.2

FIG. 21.—This map, showing the distribution of farms, might also serve as a map of farm population. The densest areas are southeastern Pennsylvania, the upper Piedmont of South Carolina and Georgia, eastern, central, and western Tennessee, the Ohio Valley, and the Yazoo Delta in Mississippi. Over half the farms in the United States are in the Cotton Belt and the Corn and Winter Wheat Region. Many of the tenant farms on the plantations in the Cotton Belt, however, are little more than laborers' allotments. The Corn Belt, although it includes over one-third the value of farm property in the United States, has only one-seventh of the farms. Nine-tenths of the farms are in the eastern half of the United States. The relative density of farm population in the South is even greater than that of farms. (U. S. Dept. Agr. Yearbook 1921.)



STATE	ACRES	PER CENT
Oreg.	2,993,388	4.9
Idaho	2,737,943	5.2
Md.	2,303,282	36.2
W. Va.	2,295,905	14.9
Fla.	1,829,864	5.2
Me.	1,650,189	8.6
Wyo.	1,210,250	1.9
N. Mex.	1,197,752	1.5
Vt.	1,192,876	20.4
N. J.	1,162,160	24.2
Utah	1,071,168	2.3
Mass.	664,043	12.9
Del.	616,665	40.1
N. H.	546,124	9.5
Conn.	519,521	16.8
Ariz.	471,345	.6
Nev.	392,520	.6
R. I.	76,197	11.2
U. S.	375,431,734	19.7

STATE	ACRES	PER CENT
Tex.	25,534,195	15.2
Kans.	22,843,587	43.6
Iowa	21,609,534	60.7
Ill.	21,462,852	59.9
N. Dak.	19,760,741	44.0
Nebr.	17,467,445	35.5
Minn.	17,145,815	33.1
Mo.	16,810,354	38.2
Okla.	15,393,796	34.7
S. Dak.	15,313,006	31.1

STATE	ACRES	PER CENT
Ohio	13,934,239	53.4
Ind.	13,223,256	57.3
Ga.	12,537,645	33.4
Wis.	10,265,998	29.0
Mich.	10,000,611	27.2
Pa.	8,998,116	29.4
N. Y.	8,904,766	29.7
Ala.	8,091,496	24.7
Ky.	7,532,641	28.3
Tenn.	7,430,888	27.9

STATE	ACRES	PER CENT
Calif.	6,850,805	6.9
Ark.	6,839,300	20.3
N. C.	6,625,069	21.2
Miss.	6,003,052	22.3
S. C.	5,852,376	20.0
Va.	5,649,414	22.6
Colo.	5,416,711	7.8
Wash.	4,251,170	9.9
La.	4,022,658	13.8
Mont.	3,924,337	4.2

FIG. 22.—Over five-sixths of the crop land is in the humid eastern half of the United States, and nearly two-thirds is concentrated in the triangular-shaped area the points of which are located in western Pennsylvania, central Texas, and north-central North Dakota. In this area, which includes only about one-fourth of the land of the United States, are produced four-fifths of the corn, three-fourths of the wheat and oats, and three-fifths of the hay crop of the nation. (U. S. Dept. Agr. Yearbook 1921.)

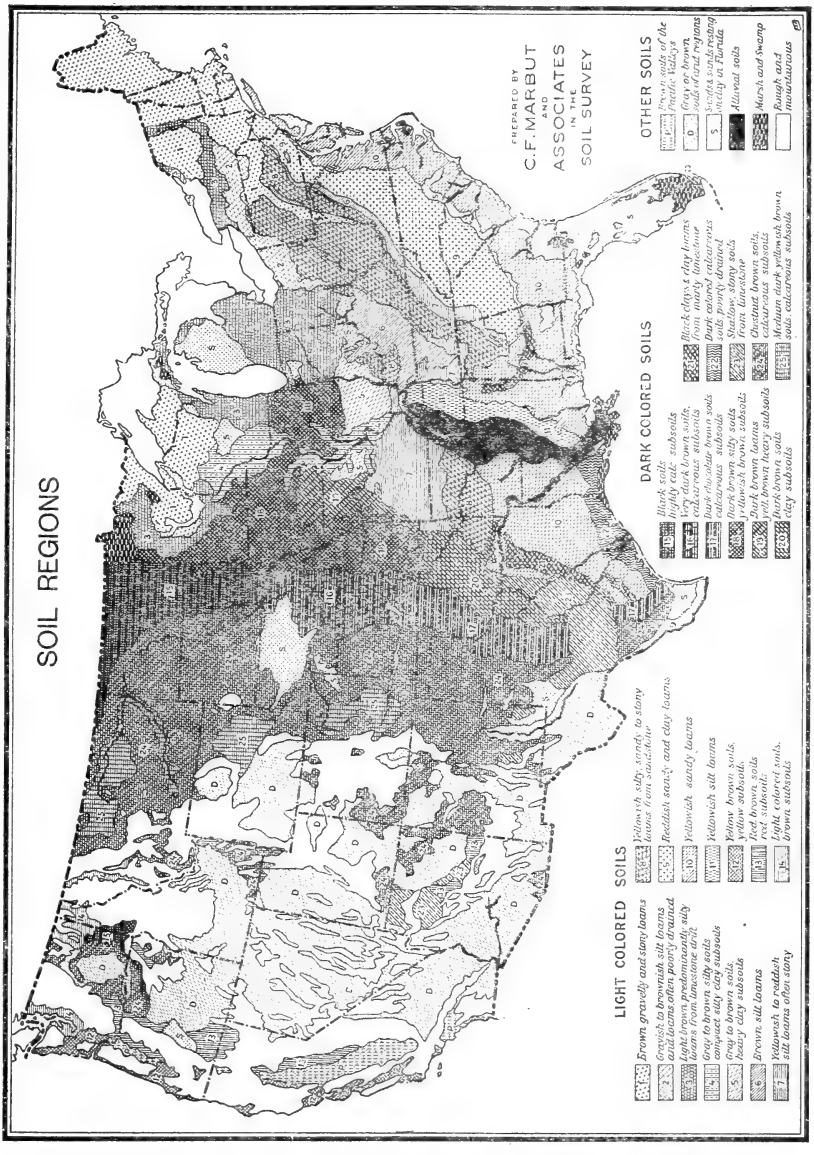
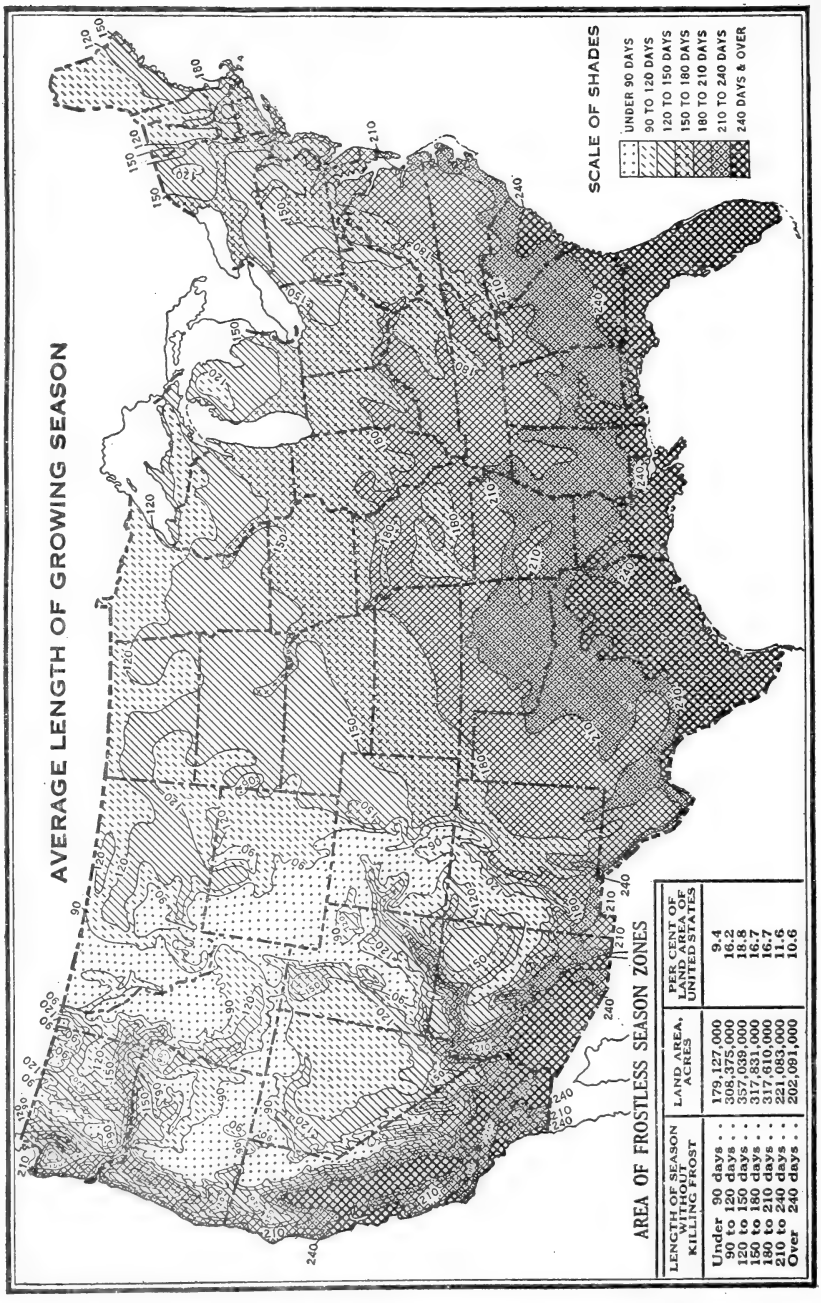
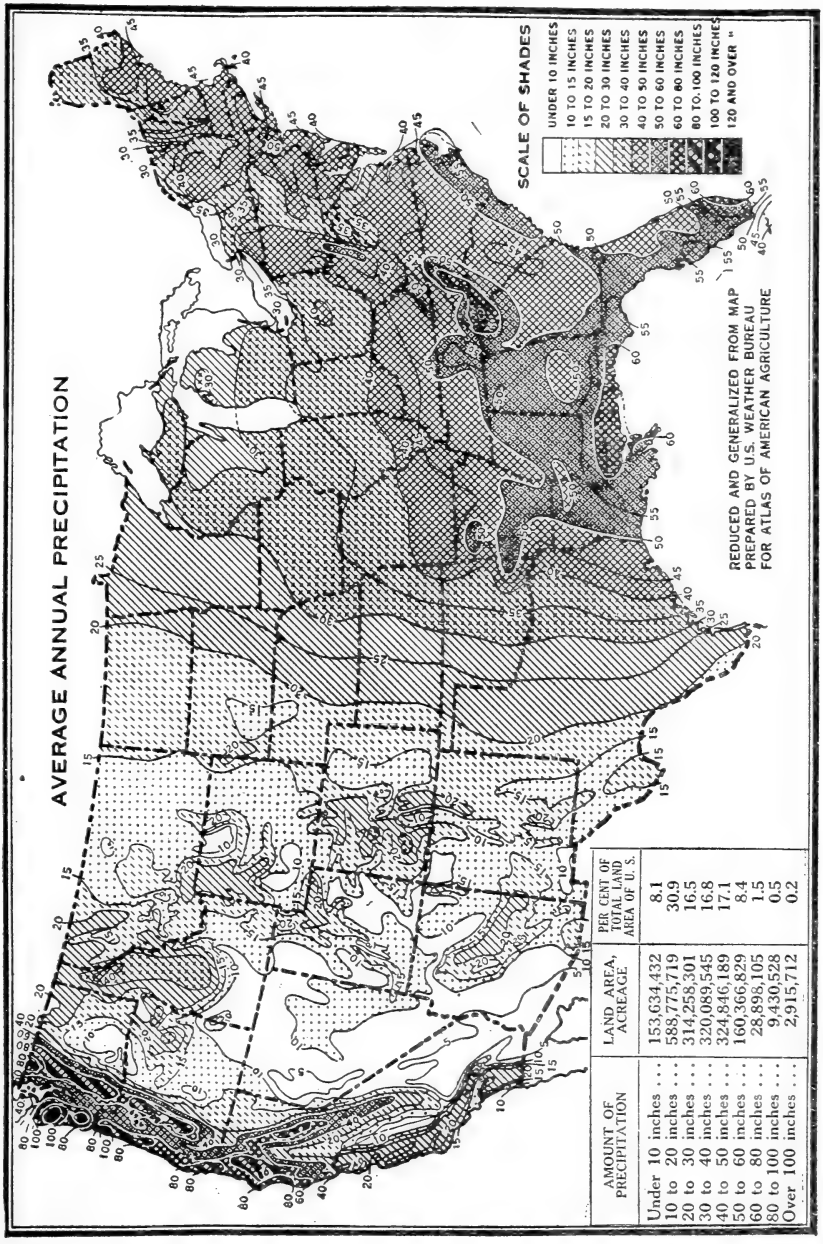


FIG. 23.—Soils originally or at present covered with forest are normally light colored, and are likely to be less fertile than soils in regions of lower rainfall. Grassland soils, in general, are dark colored, the humid prairie soils being commonly almost black and highly fertile—the subhumid prairie soils, blackest of all—while the semiarid short-grass plains soils are dark brown or chocolate colored, the color gradually fading to medium brown in regions of lesser rainfall, and to light brown or even ashy gray in desert areas. The light-colored forest soils in the United States total about 800 million acres, the dark-colored grass-land soils about 600 million acres, and the light-colored arid soils about 500 million acres. (U. S. Dept. Agr. Yearbook 1921.)



LENGTH OF SEASON WITHOUT KILLING FROST	LAND AREA, ACRES	PER CENT OF LAND AREA OF UNITED STATES
Under 90 days	179,127,000	9.4
90 to 120 days	308,375,000	16.2
120 to 150 days	337,839,000	17.8
150 to 180 days	317,831,000	16.7
180 to 210 days	317,610,000	16.7
210 to 240 days	221,083,000	11.6
Over 240 days	202,091,000	10.6

FIG. 24.—This map is much reduced and generalized from a map prepared by the United States Weather Bureau and published in the Frost and the Growing season section of the Atlas of American Agriculture. (U. S. Dept. Agr. Yearbook 1921.)



AMOUNT OF PRECIPITATION	LAND AREA, ACREAGE	PER CENT OF TOTAL LAND AREA OF U. S.
Under 10 inches . . .	153,634,432	8.1
10 to 20 inches . . .	588,775,719	30.9
20 to 30 inches . . .	314,258,301	16.5
30 to 40 inches . . .	320,089,545	16.8
40 to 50 inches . . .	324,846,189	17.1
50 to 60 inches . . .	160,366,829	8.4
60 to 80 inches . . .	28,896,105	1.5
80 to 100 inches . . .	9,430,528	0.5
Over 100 inches . . .	2,915,712	0.2

FIG. 25.—Precipitation includes rain, melted snow, sleet, and hail. The map is much reduced and generalized from a map prepared by the Weather Bureau and published in the Precipitation and Humidity section of the Atlas of American Agriculture. The map suggests why the United States should be divided agriculturally into an eastern and a western half. (U. S. Dept. Agr. Yearbook 1921.)

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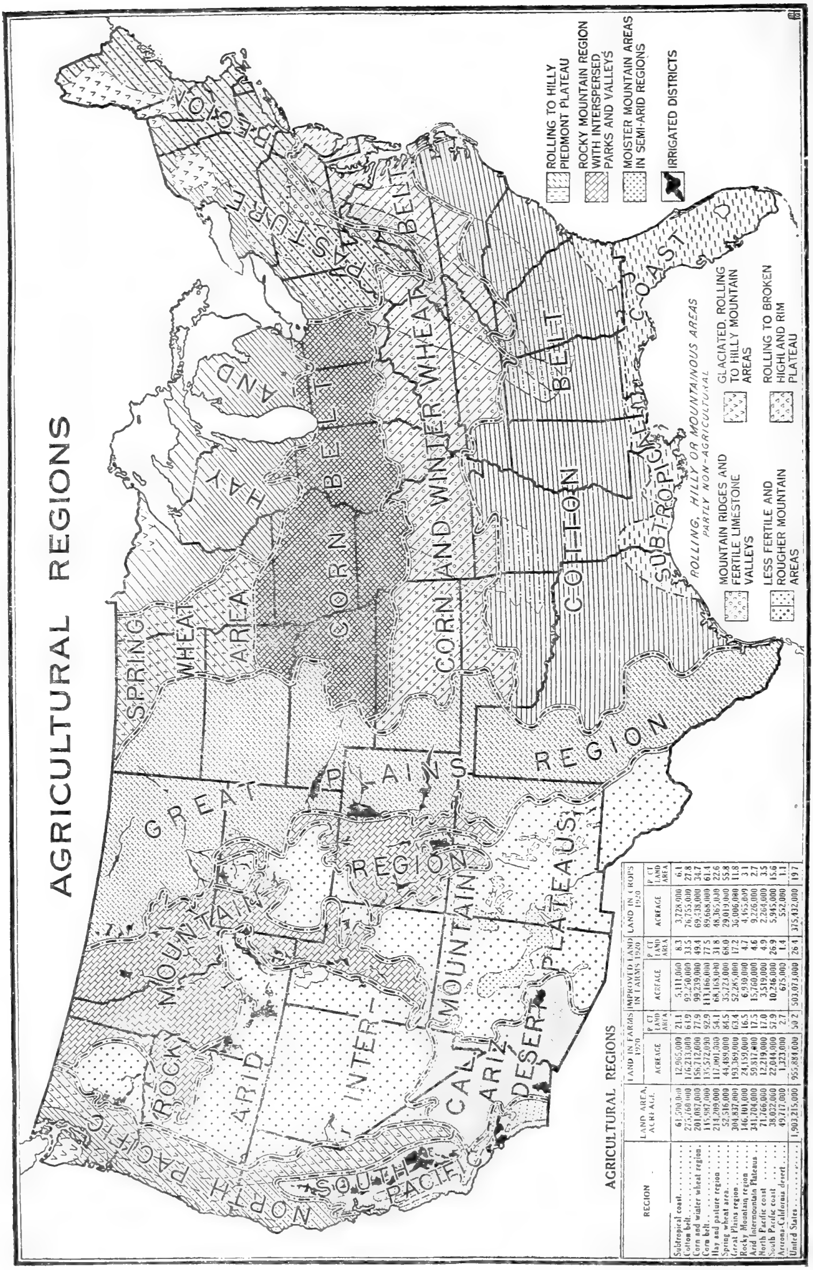


AGRICULTURAL REGIONS

REGION	LAND AREA, ACREAGE	LAND IN FARMS 1920		IMPROVED LAND IN FARMS 1920		LAND IN CROPS 1920	
		ACREAGE	P. CT. LAND AREA	ACREAGE	P. CT. LAND AREA	ACREAGE	P. CT. LAND AREA
Subtropical coast	61,590,000	12,965,000	21.1	5,111,000	8.3	3,728,000	6.1
Cotton belt	275,760,000	176,213,000	64.9	92,250,000	33.5	76,755,000	27.8
Corn and winter wheat region	201,087,000	156,712,000	77.9	99,239,000	49.4	69,438,000	34.7
Corn belt	145,987,000	135,572,090	92.9	113,166,000	77.5	89,668,000	61.4
Hay and pasture region	214,209,000	117,001,000	54.1	68,168,000	31.8	48,365,000	22.6
Spring wheat area	52,516,000	44,489,000	84.5	35,723,000	68.0	29,019,000	55.8
Great Plains region	304,837,000	193,369,000	63.4	52,285,000	17.2	36,006,080	11.8
Rocky Mountain region	146,101,000	24,159,000	16.5	6,930,000	4.7	4,465,009	3.1
Arid Intermountain Plateaus	341,704,000	59,817,000	17.5	15,760,000	4.6	9,226,000	2.7
North Pacific coast	71,766,000	12,219,000	17.0	3,519,000	4.9	2,264,000	3.5
South Pacific coast	38,032,000	22,044,900	57.9	10,246,000	26.9	5,945,000	15.6
Arizona-California desert	49,717,000	1,323,000	2.7	675,000	1.4	552,000	1.1
United States	1,903,215,000	955,884,000	50.2	503,073,000	26.4	375,432,000	19.7

FIG. 26.—The United States may be divided into two parts, equal in area, the East and the West. The East has a humid climate, the West mostly an arid or semiarid climate, except the North Pacific coast and the higher altitudes in the Sierra, Cascade, and Rocky Mountains. Each of these two parts has been subdivided into six agricultural regions, characterized by distinct combinations of crops or systems of farming, the result largely of the different climatic conditions. In the East these regions, with one exception, are named after the crops; but in the West, because of the dominating influence of topography and the Pacific Ocean upon the climate and the agriculture, topographic and geographic names are used. (U. S. Dept. Agr. Yearbook 1921.)

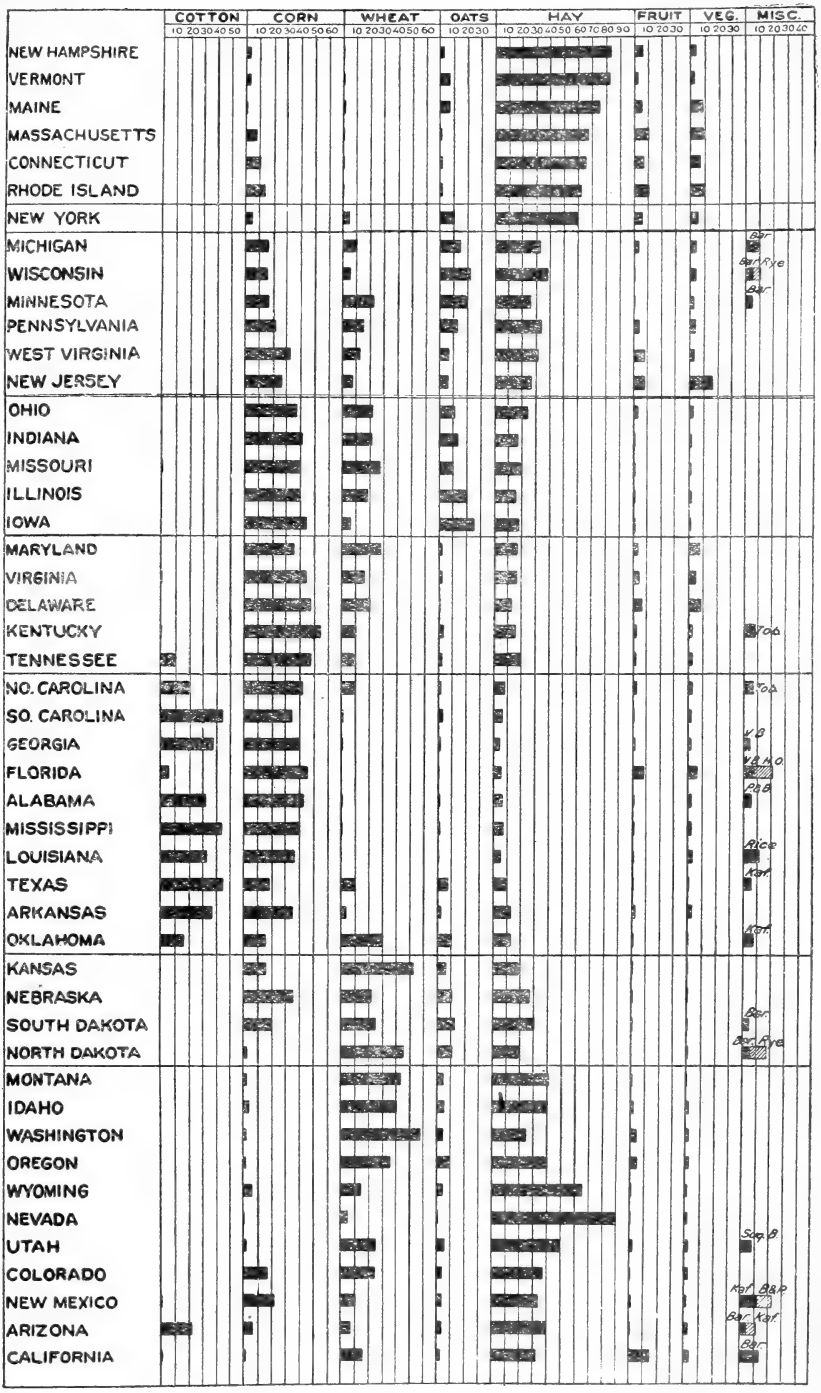
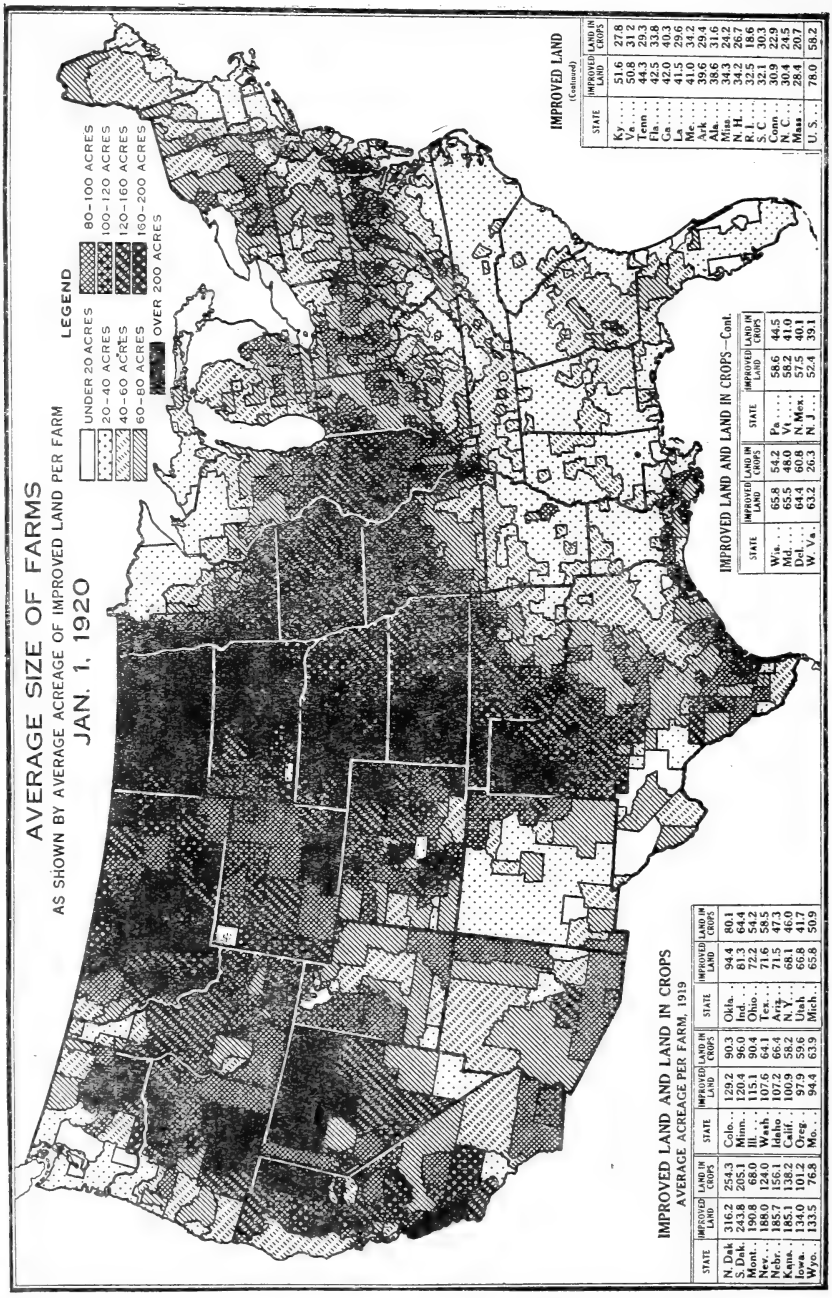


FIG. 27.—Percentage of crop area occupied in 1919 by crops named. (U. S. Dept. Agr. Farmers Bulletin 1289)



STATE	IMPROVED LAND	LAND IN CROPS
N. Dak.	316.2	254.3
S. Dak.	243.8	205.1
Mont.	190.8	68.0
Nev.	185.7	6.0
Nebr.	185.7	156.0
Kans.	185.1	138.2
Iowa.	134.0	101.2
Wyo.	133.5	76.8
Colo.	129.2	90.3
Minn.	120.4	96.0
Wash.	115.1	90.4
Idaho.	107.2	66.4
Calif.	100.9	58.2
Oreg.	97.9	59.6
Mo.	94.4	63.9
Okla.	94.4	80.1
Ind.	81.3	64.4
Ohio.	72.2	54.2
Tex.	71.5	47.5
Ariz.	71.5	47.5
N. Y.	68.1	46.0
Utah.	66.8	41.7
Mich.	65.8	50.9
Wis.	65.8	54.2
Md.	65.5	48.0
Del.	64.4	60.8
W. Va.	63.2	26.3
Pa.	58.6	44.5
Vt.	58.2	41.0
N. Mex.	57.5	40.1
N. J.	52.4	39.1
Ky.	51.6	27.8
Va.	50.8	31.2
Tenn.	44.3	29.3
Fla.	42.5	33.8
La.	42.0	24.3
Me.	41.5	29.6
Ark.	41.0	34.2
Ala.	39.6	29.4
Miss.	38.6	31.6
N. H.	34.3	24.2
R. I.	34.2	26.7
S. C.	32.1	18.6
Conn.	32.1	30.3
N. C.	30.9	22.9
Mass.	30.4	24.5
U. S.	28.4	20.7
	78.0	58.2

FIG. 28.—Improved land is a better criterion of the real size of a farm than its total area. The Cotton Belt stands out clearly, with the farms in most of the area averaging less than 40 acres. The same small acreage per farm is found in eastern New England, where trucking and dairying dominate, and in the upper Lakes area, where farms are only partially reclaimed from the forest. At the other extreme, much of the Great Plains and most of the Spring Wheat Area average over 200 acres per farm. The sharp gradation zone extending from northwestern Minnesota to Indiana, thence to central Texas, marks the eastern margin of the prairies. Prairie farms were more easily and quickly made than forest farms, and have remained larger. (U. S. Dept. Agr. Yearbook, 1921.)

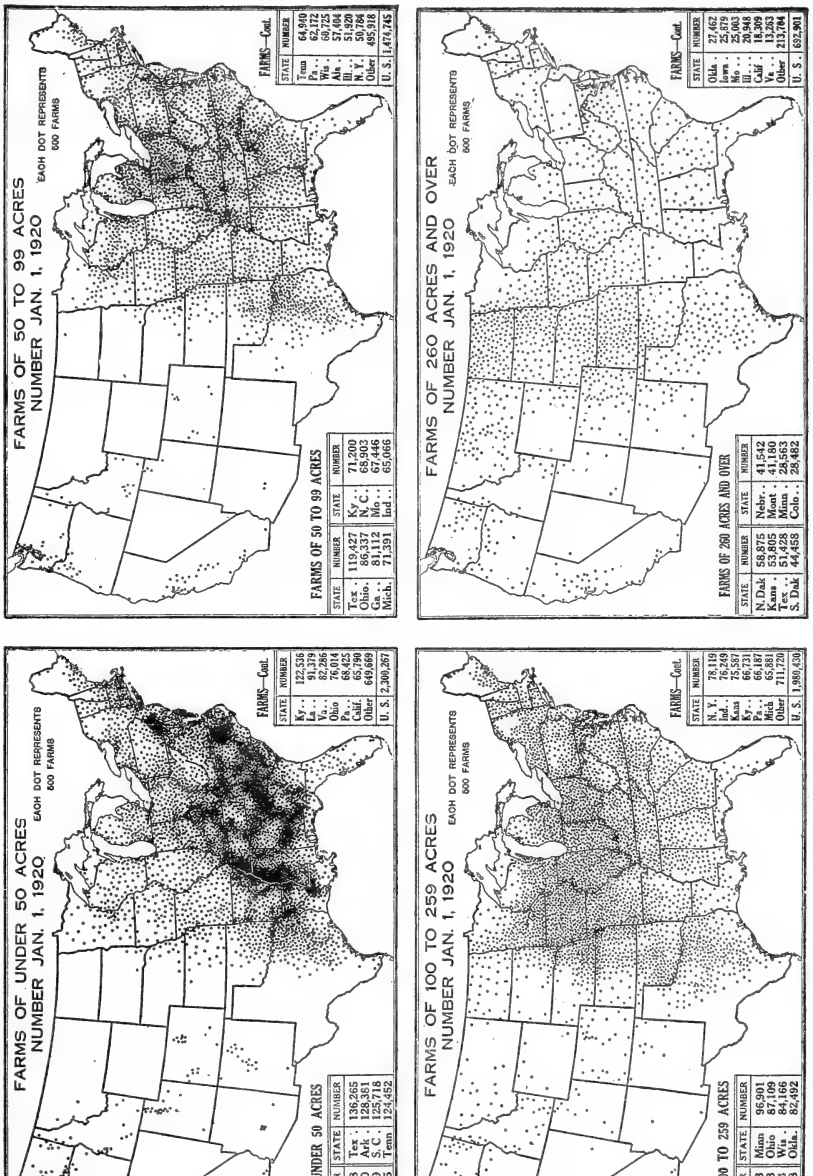


FIG. 29.—Distribution of farms of various sizes. (U. S. Dept. Agr. Yearbook 1921)

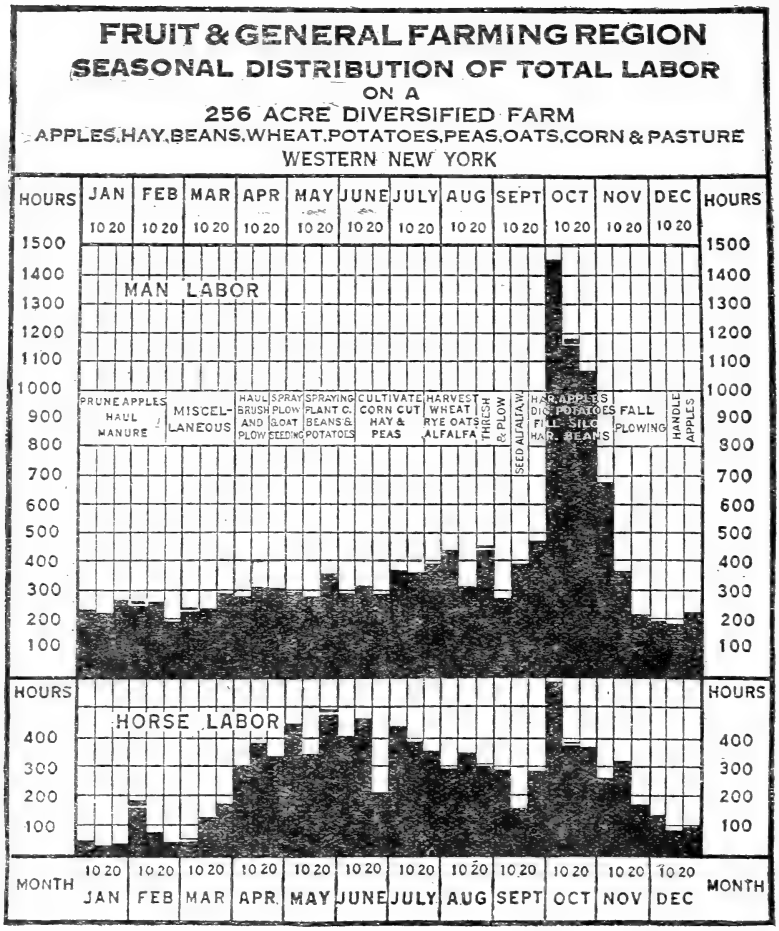
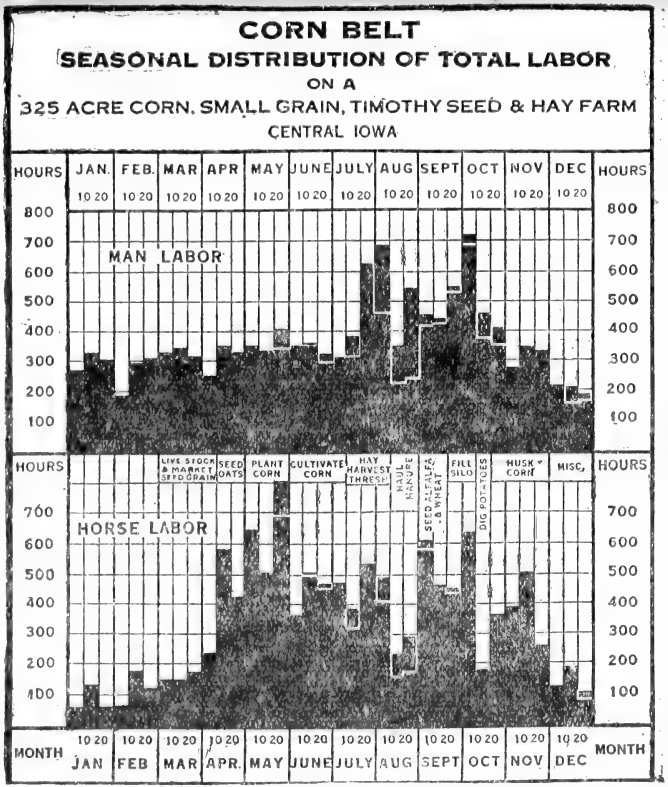
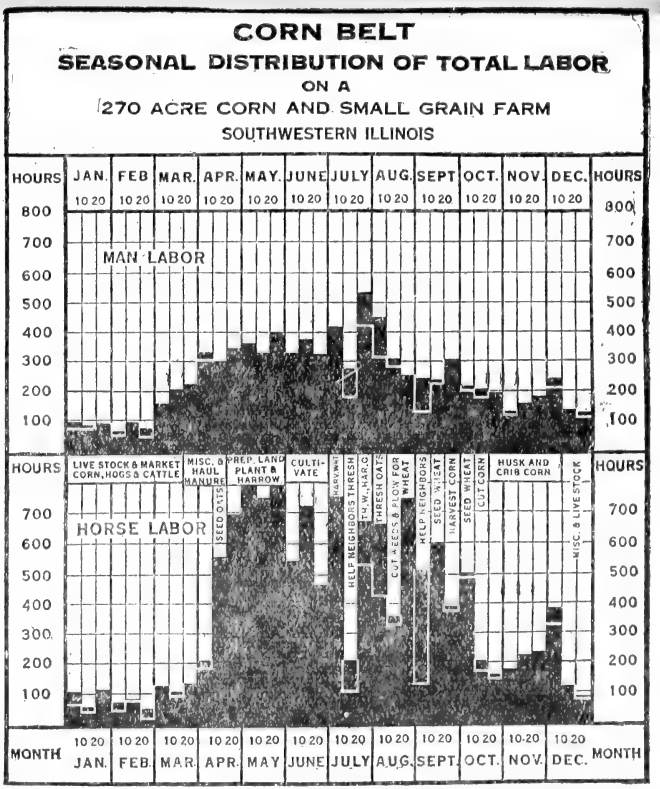


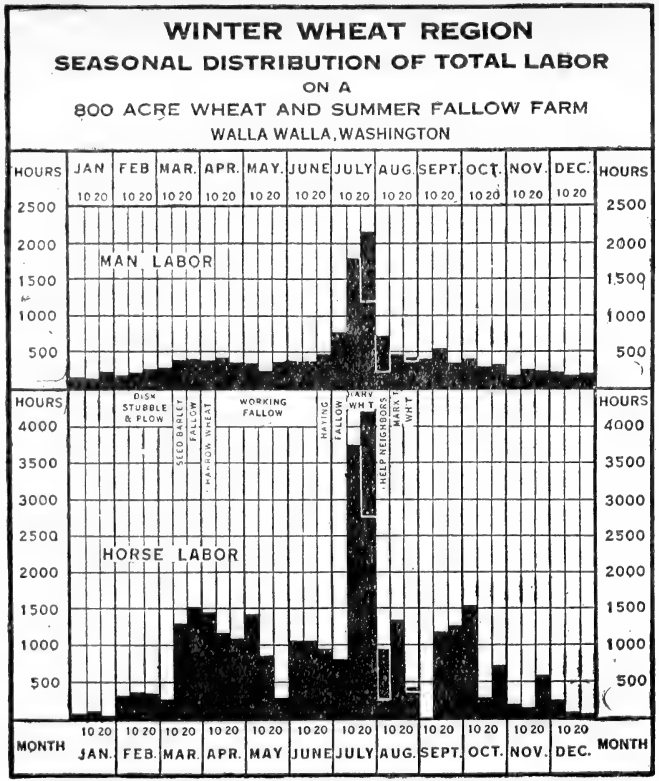
FIG. 30.—Fruit growing and general farming are the more common types of farming in western New York. The intensive fruit farms, which are found mostly within a few miles of the shores of Lake Ontario and Lake Erie and bordering the inland lakes, usually have only a few acres of farm crops. In the general farming area lying back of the fruit belt small to medium-sized apple orchards are found on many farms. The man-labor requirement on these diversified farms is quite uniform throughout the growing season with the exception of the haying and harvesting period in midsummer and again during the period of fall seeding and of bean, potato, and apple harvesting. The farm for which labor distribution is shown in the graph above is in a diversified farming region, and although an apple orchard is a common enterprise in this region it is unusual to find an orchard so large in proportion to other enterprises. There were on this farm in the year illustrated in the graph above 40 acres of apples in full bearing and 2 of pears, 48 of hay, 26 of wheat, 19 of beans, 19 of oats, 15 of peas, 12 acres of corn for silage, 9 acres of rye, 7 of potatoes, 7 of pasture, and a half acre of cabbage and other vegetables. Two men were hired by the year, another man was employed during July and August, and during the latter half of September 2 to 4 extra men were hired by the day. During October and early November a force varying from 8 to 24 in number was employed in picking and packing the apple crop.

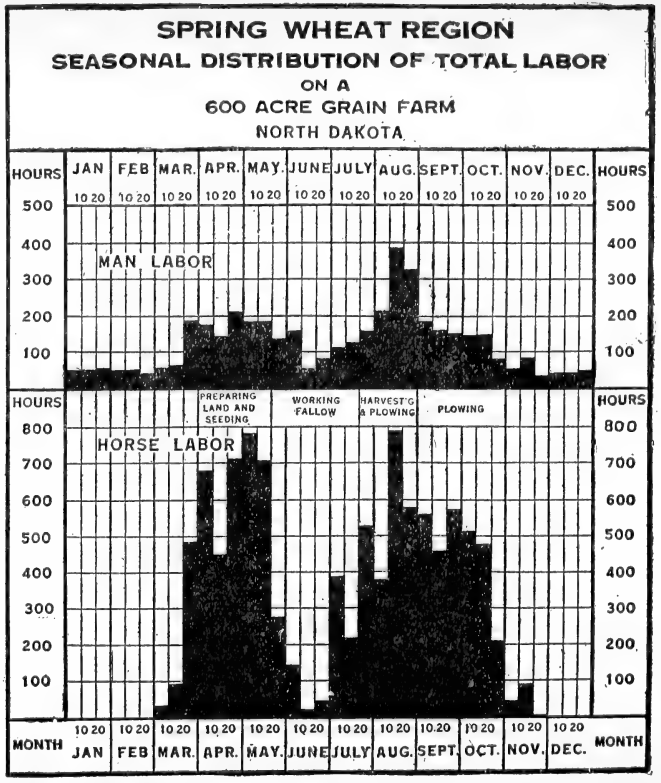
NOTE.—In figs. 30 to 36, inclusive, each small rectangular area in black represents a total of 100 hours' labor spent in a 10-day period. The white lines that sometimes divide the shaded mark off time spent working off the farm. (U. S. Dept. Agr. Circ. 183.)





FIGS. 31 and 32.—In the Corn Belt, especially where small grain and hay are important crops and livestock is fed, the seasonal requirements of man labor are, perhaps, more evenly distributed than in other agricultural areas in the United States, except the dairy belt. The peak load of work is likely to occur the latter part of July and early August, when haying, harvesting and shock threshing are in progress. The horse labor is less uniform in amount than man labor and reaches its peak load usually in April and May and again in the early fall. Where corn is cut for silage the peak load at this time is intensified. On the Iowa farm, which had 102 acres of corn, of which 26 were cut for silage, 48 acres of oats and a few acres each of barley, winter and spring wheat, together with 63 acres of hay, the farmer hires two men by the year, and when a larger crew is needed, exchanges work with his neighbors. The Illinois farm had 140 acres of corn, 54 of oats, 51 of wheat, and the labor, in addition to that of the farmer himself, consisted of two men hired during the season from March to December. He also exchanges labor with his neighbors. (U. S. Dept. Agr. Circ. 183.)





FIGS. 33 and 34.—In the regions where wheat is the important crop, the heaviest demand for man labor comes at harvest time, which in North Dakota and Washington occurs during the latter half of August. In the spring-wheat region an earlier peak load, less accentuated but of longer duration, occurs during April and early May, when the preparation of the land and the seeding first of wheat and then of oats, barley or flax takes place. In eastern Washington work on summer fallow is also required at this time. On the Dakota farm, which had 280 acres of spring wheat, 127 acres of oats, 60 acres barley, 49 acres flax, 20 acres hay, and 52 acres fallow, 2 brothers did all the work except during the harvesting and threshing season, August 1 to September 10, when 1 to 3 day laborers were employed. In this region it is customary to hire the threshing done, the thresher furnishing nearly all of the labor required. This labor does not appear on the graph. The eastern Washington farm had in this year 317 acres in wheat, 14 in emmer, 33 in pasture crops, and 374 acres of summer fallow. The labor force, in addition to the farmer himself, consisted of one man hired by the year and two men hired for the greater part of the year. The farmer hired, in addition, 10 to 20 transient laborers during two weeks of harvest time and exchanged labor with a neighbor. In eastern Washington wheat is harvested and threshed in one operation by the combine. (U. S. Dept. Agr. Circ. 183.)

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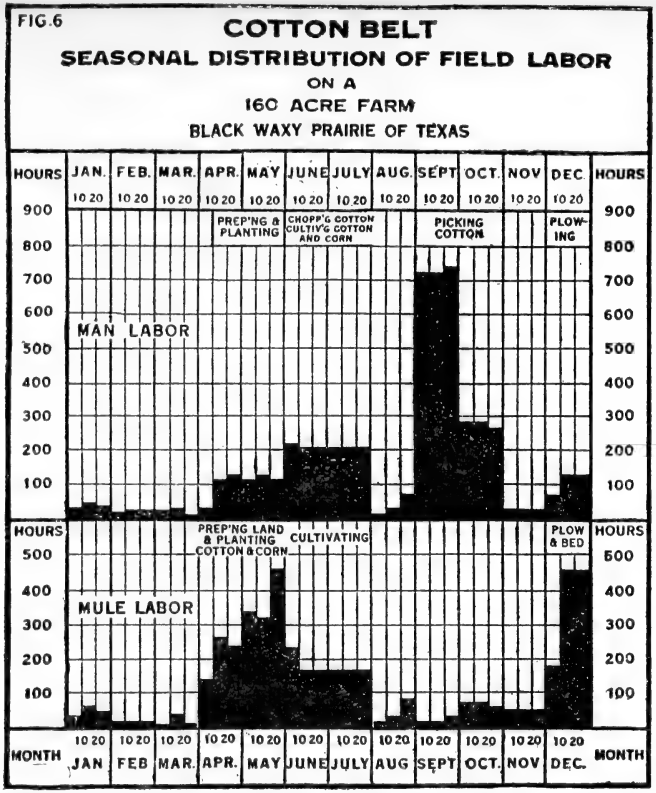

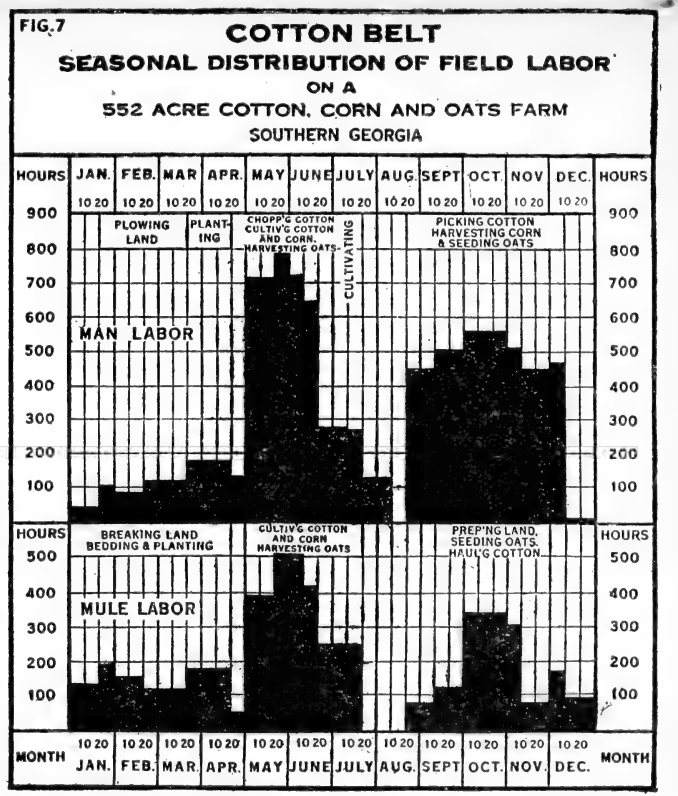

FIGS. 35 and 36.—In the Cotton Belt the peak load of man labor occurs when the small cotton plants are "chopped out," or thinned, and hoed during May, June, and early July, and again when the cotton is picked during the fall months. The greatest demand for mule labor occurs during late April to June, when both cotton and corn require cultivation and cowpeas are seeded, and again in the late fall and winter, when cotton is hauled to the gin, oats are seeded, and the land is plowed for next year's cotton and corn crops. In the northern portion of the Cotton Belt or on heavy soils farther south, the peak load of mule labor is frequently shifted to early spring. On the Texas farm, which had 117 acres of cotton, 16 of corn, 3 of oats, and 3 of sorghum, the farmer and three sons did all of the work, except picking. During September and early October a colored family of four was hired to help in picking cotton. The Georgia farm is more diversified than is usual in the South. It had 75 acres of cotton, 90 of corn and peanuts, 80 of oats, 3 acres of sweet potatoes, and 1 acre of sugarcane. The peanuts and sweet potatoes were "hogged off." The labor force consisted of five colored croppers, with a small amount of day labor hired to help in harvesting oats. The cotton and corn were all grown by the croppers, the other crops by the farmer. (U. S. Dept. Agr. Circ. 183.)

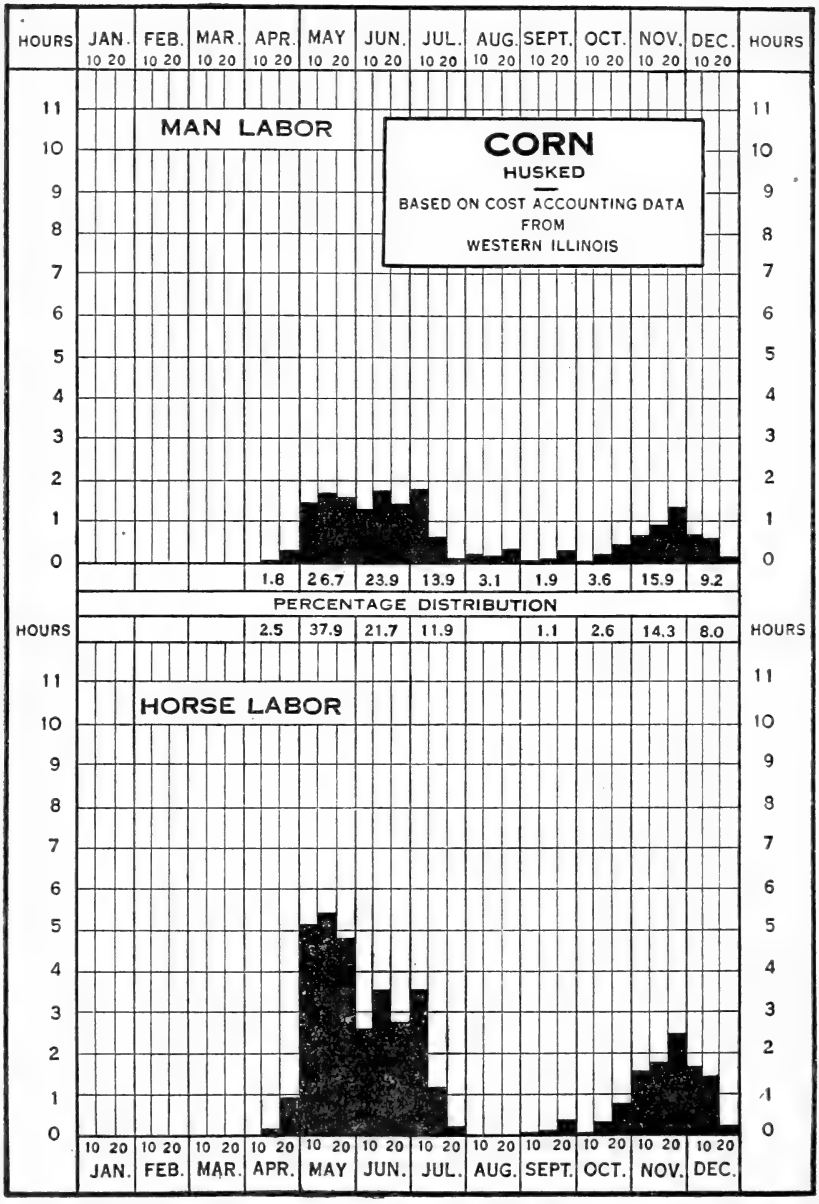

FIG. 37.—Distribution of man labor and horse labor for nine farms producing a total of 426 acres of corn. Most of the corn on these farms was husked from standing stalks. Black bars indicate total hours spent per acre during 10-day periods. (U. S. Dept. Agr., Department Bulletin 1000.)

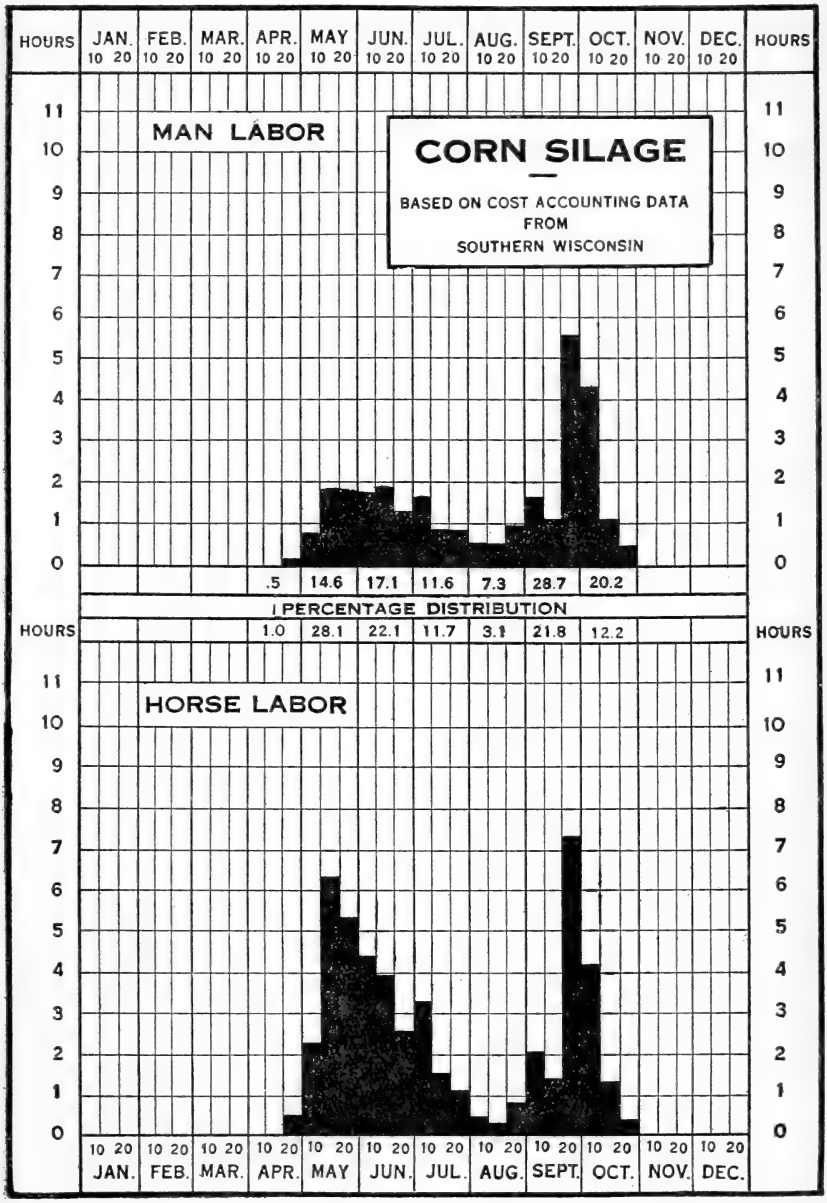

FIG. 38.—Distribution of man labor and horse labor for 13 farms having a total production of 325 acres of corn silage. Black bars indicate total hours spent per acre during 10-day periods. (U. S. Dept. Agr., Department Bulletin 1000)

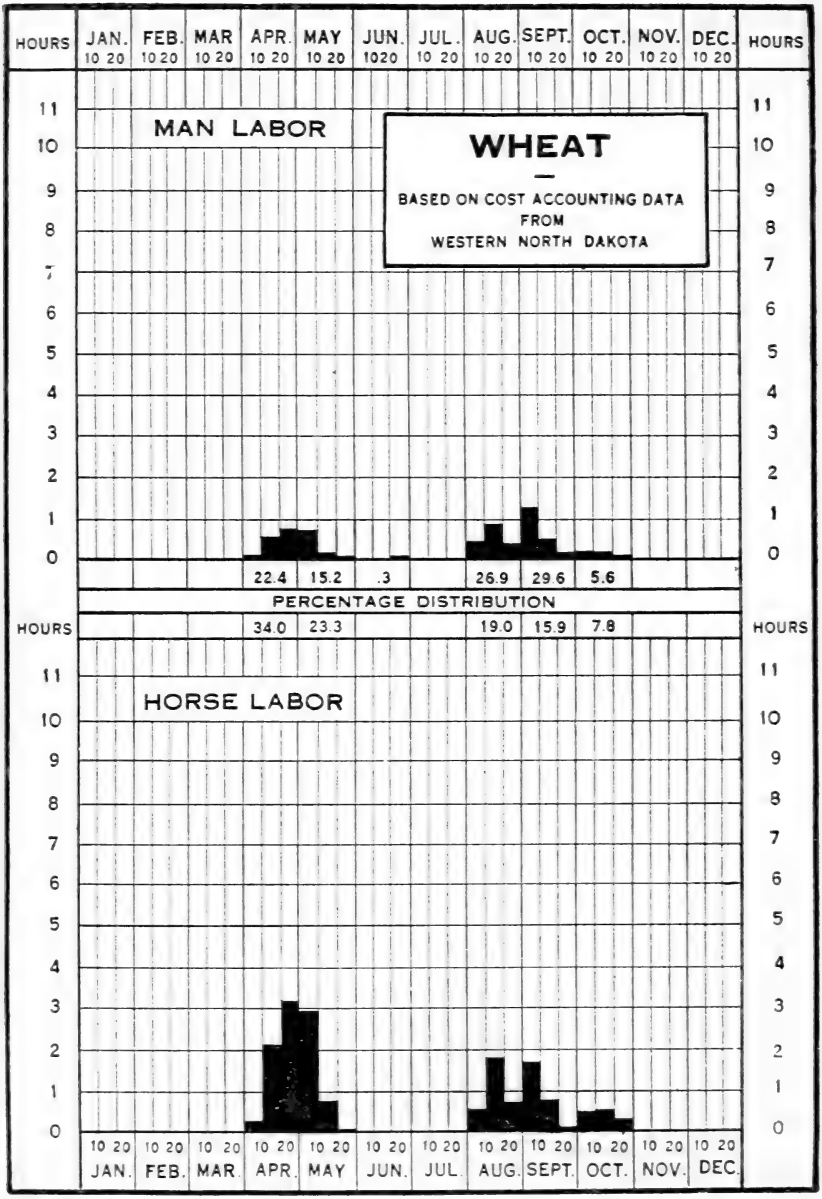

FIG. 39.—Distribution of man labor and horse labor per acre for 16 farms, representing the production of 960 acres of wheat. On 11 of these farms the thresher furnished a part or all of the crew for threshing. Black bars indicate total hours spent per acre during 10-day periods. (U. S. Dept. Agr., Department Bulletin 1000)

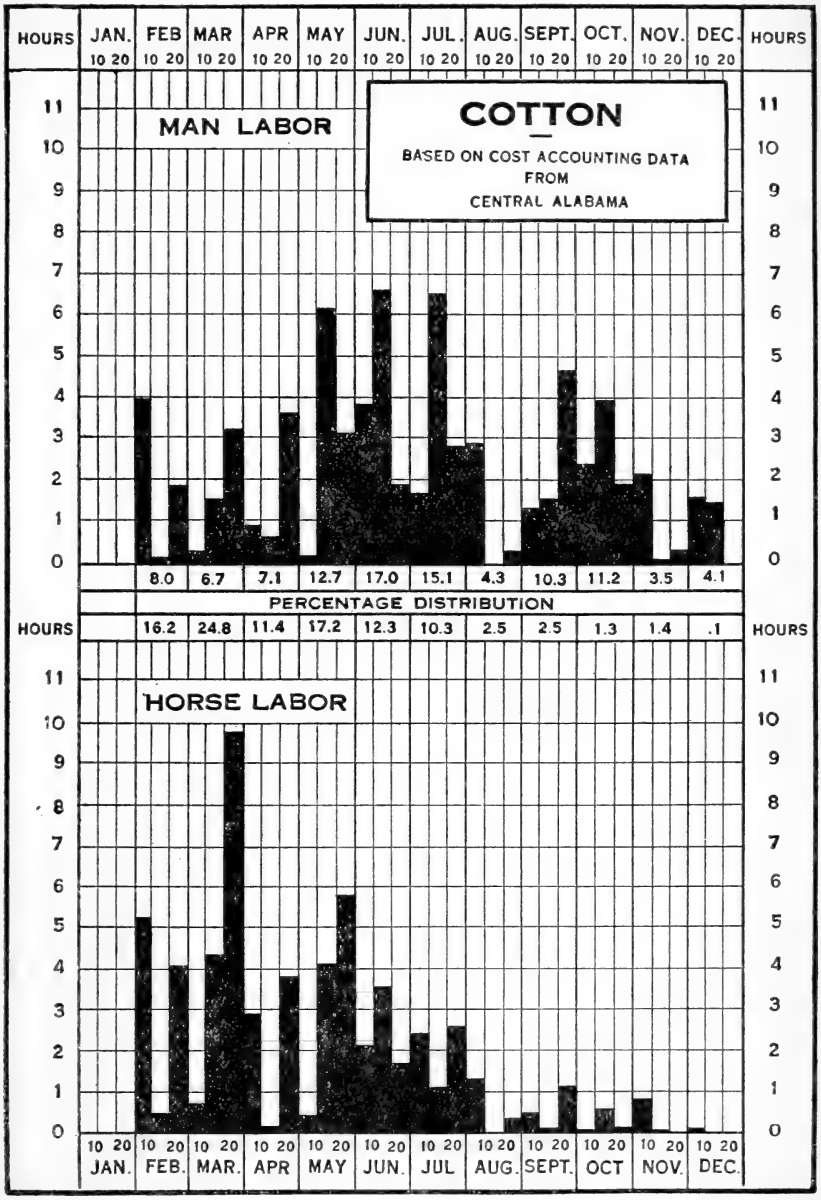

FIG. 40.—Distribution of man labor and horse labor for one farm during a series of years, representing the production of 25 acres of cotton annually. Large type machinery used. Black bars indicate total hours spent per acre during 10-day periods. (U. S. Dept. Agr., Department Bulletin 1000.)

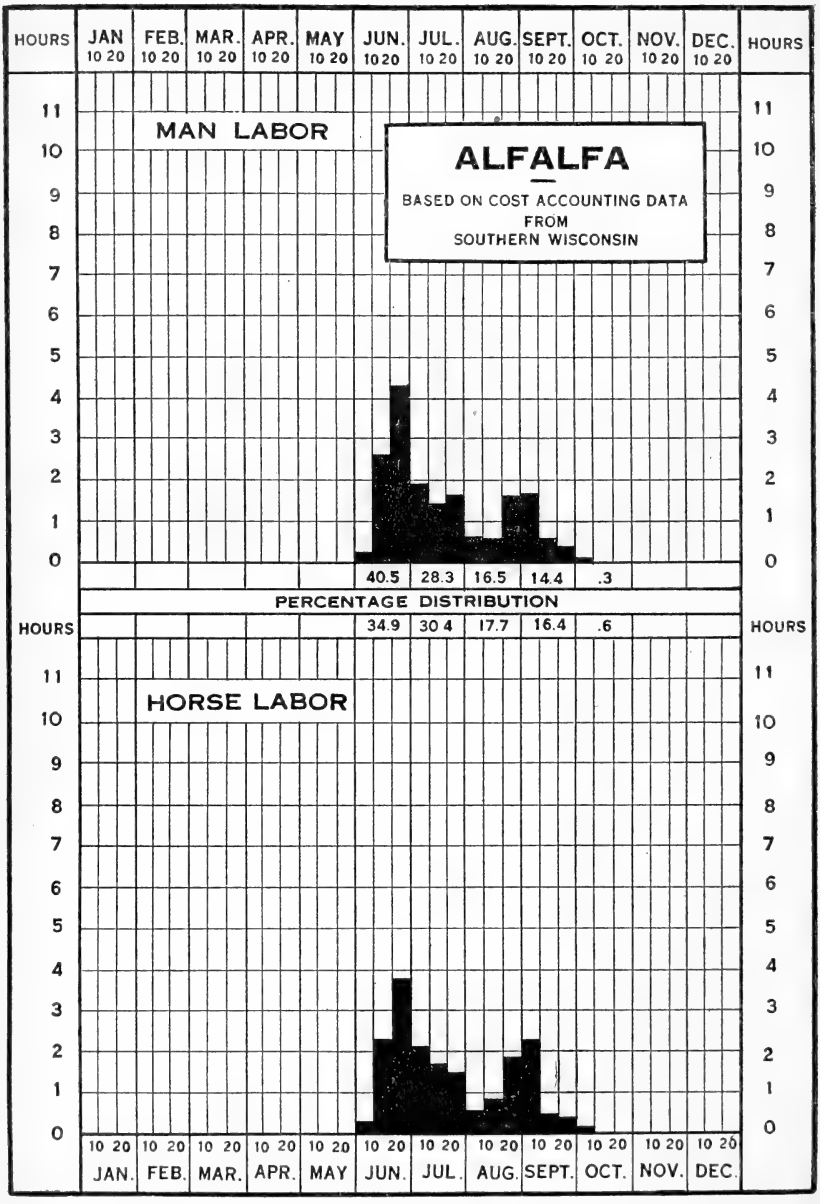

FIG. 41.—Distribution of man labor and horse labor for 20 farms, representing the production of 128 acres of alfalfa. The reports show that the first and second crops may overlap during the period July 10 to 20. Black bars indicate total hours spent per acre during 10-day periods. (U. S. Dept. Agr., Department Bulletin 1000.)

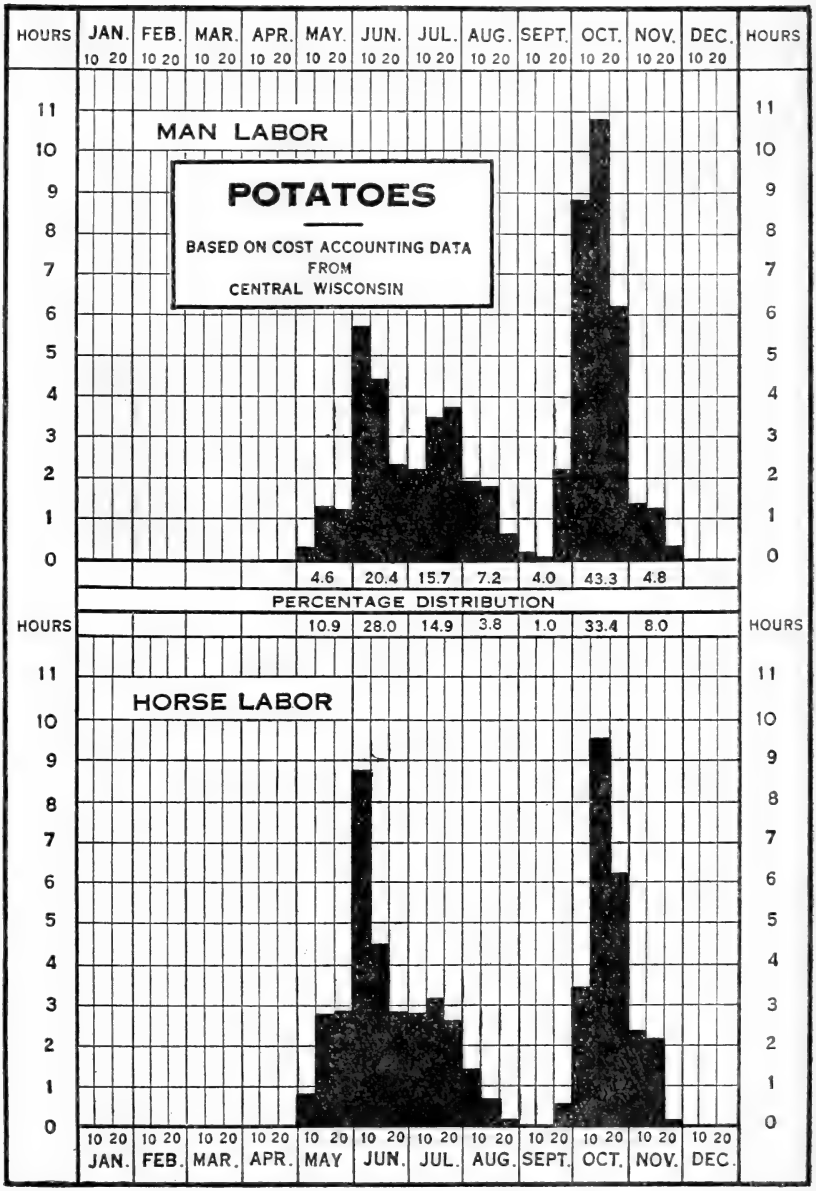

FIG. 42.—Distribution of man labor and horse labor per acre for 14 farms representing 161 acres of potatoes. Only marketing done directly from the field included. Black bars indicate total hours spent per acre during 10-day periods. (U. S. Dept. Agr., Department Bulletin 1000.)

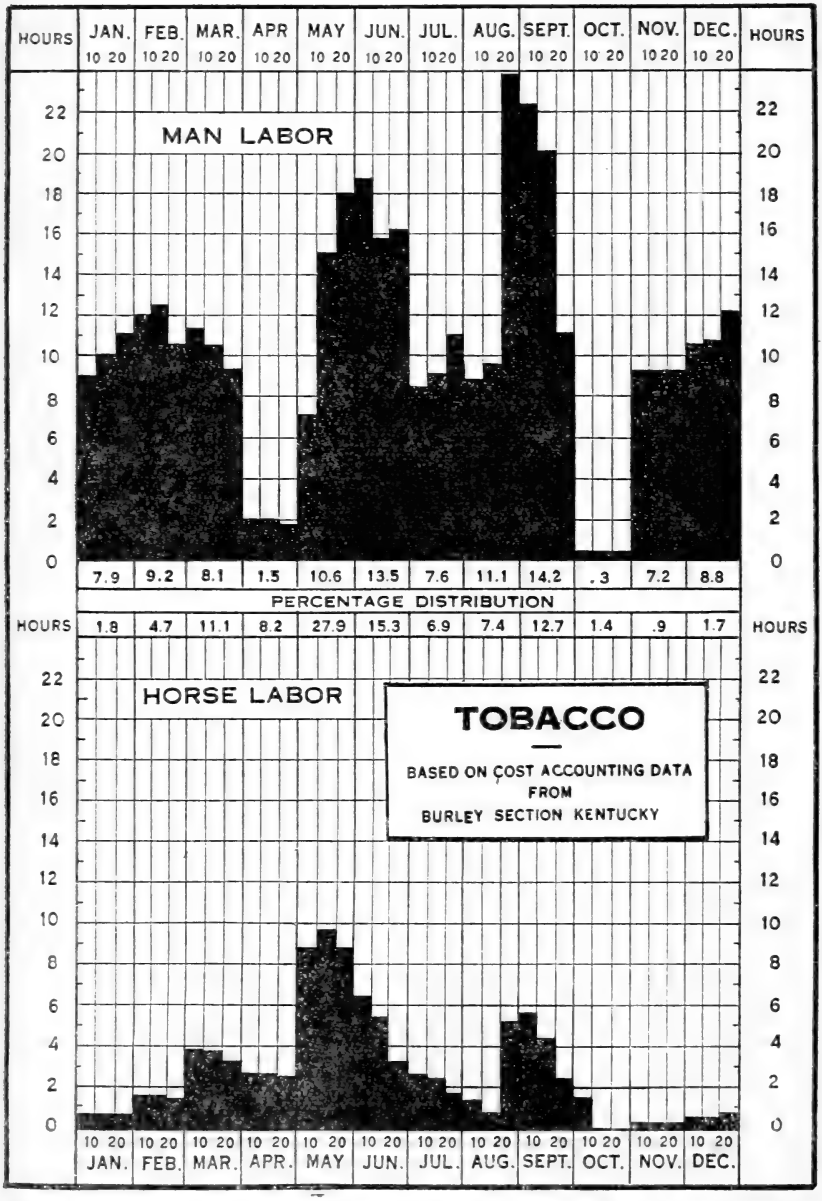

FIG. 43.—Distribution of man labor and horse labor as shown by reportes from 12 farms. Labor for marketing included. Black bars indicate total hours spent per acre during 10-day periods. (U. S. Dept. Agr., Department Bulletin 1000.)

FIG. 44.—Distribution of man labor on seven work horses. Hours shown is time required per week. (U. S. Dept. Agr., Department Bulletin 1271.)

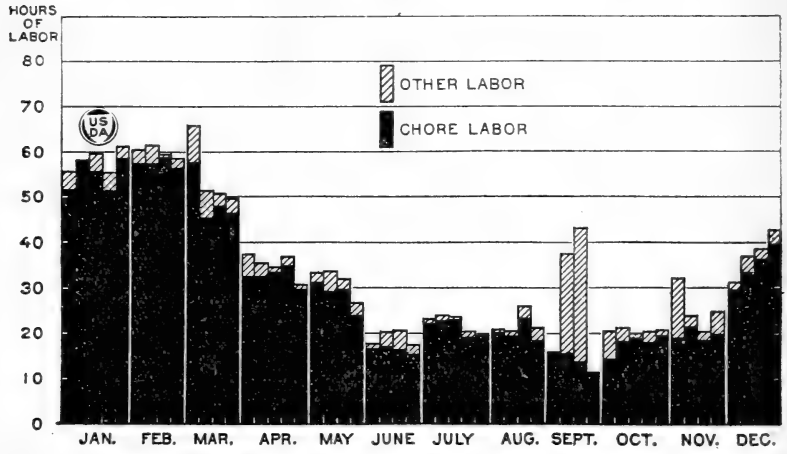

FIG. 45.—Distribution of man labor on eight dairy cows. Hours shown is time required per week. (U. S. Dept. Agr., Department Bulletin 1271.)

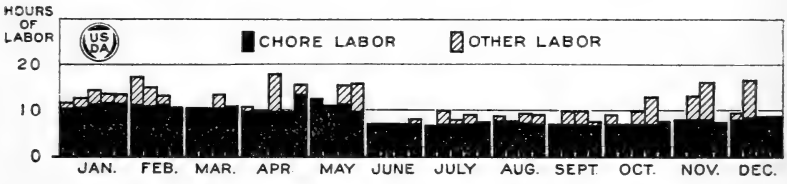

FIG. 46.—Distribution of man labor on hogs. (16,000 pounds of pork produced during the year.) Hours shown is time required per week. (U. S. Dept. Agr., Department Bulletin 1271.)

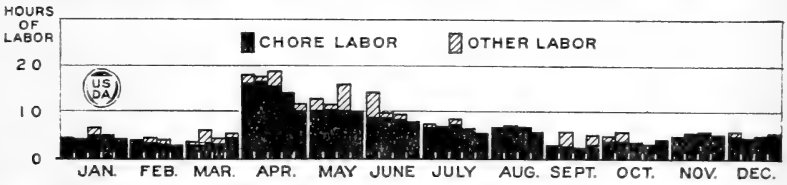

FIG. 47.—Distribution of man labor on poultry. (160 chickens in flock.) Hours shown is time required per week. (U. S. Dept. Agr., Department Bulletin 1271.)

Such conditions result in very low power-load factors and a relatively high cost per unit of power utilized. The farm operator could often reduce the peak load somewhat by reducing the proportionate acreage of the crop on which the peak load occurs; however, he is usually justified in retaining the high acreage of the crop in question because of possible relatively higher net returns

which more than make up for the higher cost of the power used. (See Department of Agriculture Circular 183, "Seedtime and Harvest," and Yearbook Separate 825, "The Horsepower Problem on the Farm.")

Table XVIII shows the average percentage of the total year's work done each month for all types of farming in each State as estimated by crop reporters of the division of crop and livestock estimates, Bureau of Agricultural Economics, and the following is a classification of the principal farm operations requiring power, with respect to the time they must or may be done:

Work that must be done at a definite time:

Spring plowing; seed-bed preparation; seeding; cultivating; harvesting small grain, tame hay, and other perishable or seasonable crops, shock threshing; cutting corn and filling silo; marketing perishable or seasonal products; spraying crops; emergency repairs of equipment; regular care of livestock; most household operations for which power is used.

Work that may be done within seasonal limits:

Most fall plowing; harvesting wild hay and other nonperishable crops; husking; shelling and shredding corn; stack or barn threshing; baling hay; grinding, grading, and cleaning grain; shearing sheep; pruning trees; marketing livestock; hauling feed, fertilizer, and most general supplies.

Work that may be done at any time during the year:

Marketing nonperishable products; general hauling; cutting wood; grinding limestone; general repair work on equipment; most building construction.

Work that may be done while ground is wet:

Harvesting most crops; shelling or shredding corn; filling silo; cutting wood; pruning trees; marketing crops and livestock products, and general hauling.

Work requiring fairly dry ground:

All tillage operations; most seeding operations; harvesting hay and crops grown underground; stacking and threshing small grain.

Work that can not be done while ground is frozen:

All tillage, seeding, cultivating, and harvesting operations except husking corn.

FACTORS AFFECTING THE EFFICIENT UTILIZATION OF POWER AND LABOR ON FARMS

As previously mentioned, the most serious factor affecting the efficient utilization of power and labor on farms is the extreme seasonal demand of many of the farm operations. Other factors that have an important effect on the efficiency are: The diversity of operations on any given farm; the short periods during which the majority of the individual operations are carried on in a year; the low load factor, that is, the small percentage of time a large part of the power equipment is in use during the year; and the small size of the power unit commonly under the control of one worker.

The diversity of farm operations, together with the short time the majority of these various operations are carried on, prevents the most efficient utilization of power and labor because of the time lost in getting each new operation under way, owing to the necessity of

readjusting the equipment each time it is used and to the lack of that degree of familiarity of the operator with each new implement used that would obtain were he to use practically the same tools each day of the year.

The necessity of keeping a large primary power plant available to take care of the occasional peak loads that occur in most types of farming results in an average load factor of only about 4 per cent; and since fixed charges represent a considerable part of the cost of operating power equipment, the result is a relatively high cost per unit of power produced. (See page 8.)

In considering the costs per unit of the different kinds of power developed as given on page 8, it should be understood that the kinds of work done are not the same with each kind of power and for this reason the rates are not directly comparable. Operations vary greatly in regard to the efficiency with which power may be applied, and if exactly the same work were to be done by any two of the different kinds of power shown the cost per unit of each might vary considerably from the values given. It should also be understood that the unit used in showing costs is the horsepower-hour which is a measure of work done, and therefore that these values can not be directly compared with the horse-hour unit which is commonly used in cost-accounting studies but which expresses only time expended and not the actual work accomplished in each operation performed.

The size of power unit employed affects the cost of an operation in several ways. The larger the power unit the quicker can a given amount of work be accomplished, with a proportionate saving in human labor, as a rule. Where the operation applies to some crop, it is also probable that the use of the larger unit will result in the work being done in more nearly the correct time and that a larger crop yield may be obtained by this means, although only a limited amount of information is so far available with regard to this.

On the other hand, unless the power plant and machinery are employed at other work during the time saved, there will be a greater overhead cost for this equipment, with a resulting higher cost per unit of work accomplished for these two items; and although under ordinary conditions the saving in labor will more than equal the extra cost of the power and machinery, there is a limit beyond which this is not true. This is illustrated for a specific case of 100 acres of crops in the western Corn Belt in Figure 48. With conditions as given it will be seen that, up to a certain point, as the size of the power unit employed is increased there is an increase in the net profits from the production of crops on this farm, through reduced labor costs and increased yields, but that beyond this point the extra overhead cost of the larger equipment more than offsets the saving in labor costs.

It should be noted that the results shown in Figure 48 are directly applicable only to farms operated under exactly the same conditions as the one shown. If the soil should be of a nature to require more or less work in its preparation, if the proportion of crops produced should be different, if a different farm practice were followed in caring for the crops, if the total crop acreage were different, or if the cost of labor or power were different, the most profitable size of power unit also would probably be somewhat different from that shown.

The rate paid for labor, particularly, has much to do with deciding the most profitable size of power unit. The lower the wages paid the smaller will be the most profitable size of unit, and the higher the wages the larger will be the most profitable size. This partially explains why smaller power units are more common where relatively low wages prevail.

This same condition applies when the adding of additional types of power to the farm equipment is contemplated. Unless the added power equipment is used entirely to replace human labor, or a proportionate part of the original power equipment is disposed of, there is danger of the load factor of the original equipment being reduced

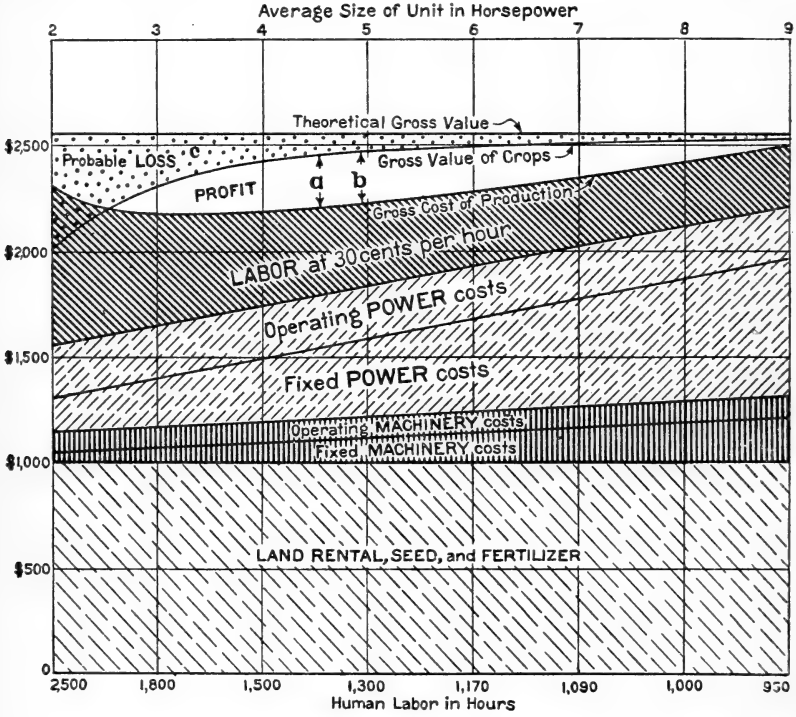

FIG. 48.—Effect of size of power equipment on profit or loss in crop production, a represents maximum profit on investment, b maximum profit on labor, c probable loss in total crop value attributed to lack of equipment (100 acres composite crops in western Corn Belt)

and the total operating cost increased thereby through increased overhead to a point where the total net returns from the farm will be actually decreased rather than increased, even though the unit cost of the new power is considerably lower than in the case of the old.

This is exactly what occurs frequently when a tractor is added to the power equipment of a farm, unless the farming system is so managed that a proportionate part of the animal power formerly used is disposed of. Although the tractor will, under most conditions, develop a given amount of power considerably cheaper than the same amount can be developed by animal power, care must be taken that the load factor of the remaining animal power is not

reduced to the point where the increased cost of this power per unit of work done amounts to more than the saving accomplished through the use of the cheaper tractor power. Tables XIX and XX show the average cost of horse and tractor power on farms in the United States under 1924 conditions for different amounts of power produced annually; and Figure 49, based on these tables, illustrates graphically the reason for increased rather than decreased power costs that frequently takes place when a tractor is added to the farm equipment without disposing of a proportionate part of the original animal power equipment, as has been determined by many cost-accounting studies.

Figure 50 shows the average crop-acres per farm worker in the various States. (The type of farming followed and the topography

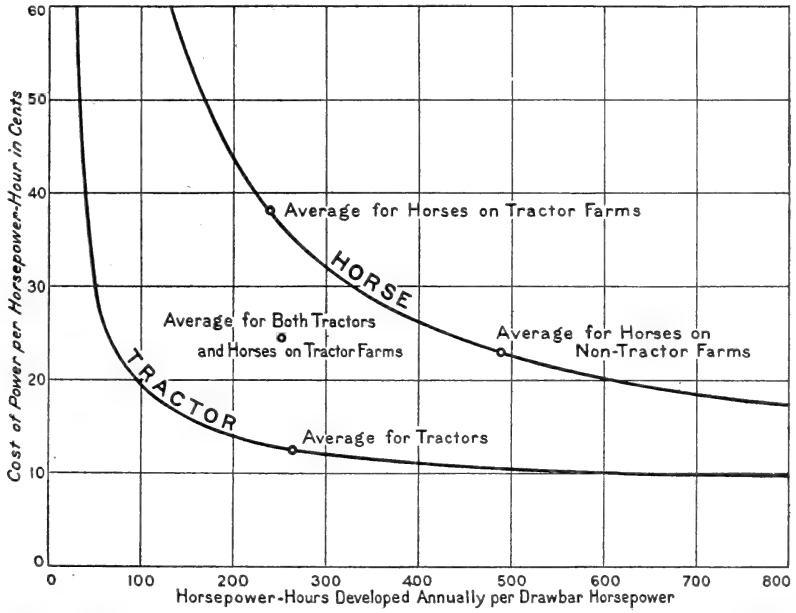

FIG. 49.—Effect of power load factor on cost per unit of power developed and effect of using horses and tractors on same farm under average conditions. An equivalent quantity of animal power should be disposed of when adding mechanical power to the farm equipment if the total power costs or the average cost per unit of all power utilized is to be reduced

of the land available for farming are also factors that affect the size of power units used and the crop-acres per worker.)

CHOICE OF POWER

In choosing a type of power for farm use, the kind of farming followed and local conditions should be given first consideration. The power should, of course, be adapted to the kind of work to be done and the proportion of the total work on the farm that can be done by each kind of power under consideration is a matter of importance. Other factors that should be considered are the local cost of fuel, feed, etc., attention required by the power plant while in operation, care required while not in use and adjustments to be

made when preparing to work, availability when wanted, comfort of the operator, range of speeds available for specific kinds of work, reserve power available for emergencies, etc. For the small job, requiring little power with a resulting small cost, convenience or ease of operation probably is of greatest importance, but for the larger operations economy in getting the work done should be the principal deciding factor in the choice of power.

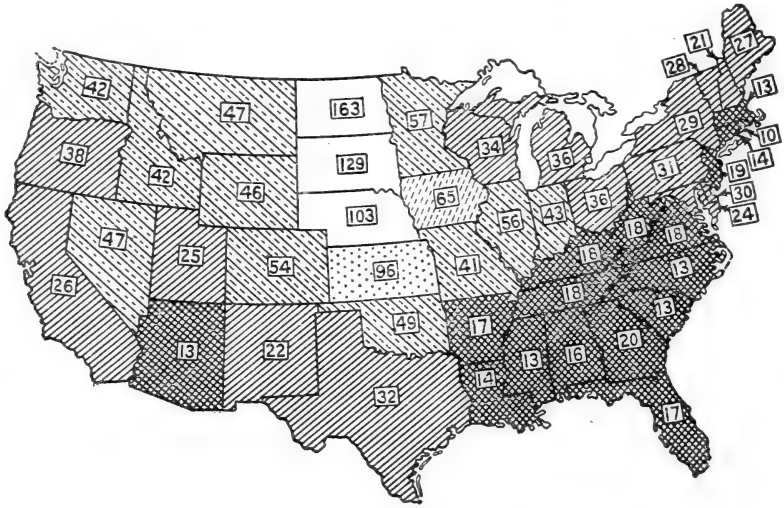

FIG. 50.—Crop acres per farm worker based on 1920 census

The following outline compares some of the principal advantages and disadvantages of the different kinds of power as they are now used on farms:

ADVANTAGES AND DISADVANTAGES OF DIFFERENT KINDS OF POWER USED ON FARMS

ADVANTAGES	DISADVANTAGES
Animals:	Animals:
Great reserve power for emergencies and temporary overloads.	Require feed and care when not working.
Use feed produced largely on the farm.	Work at heavy loads limited to short periods.
Great flexibility of size of power unit.	Require frequent resting periods.
Adapted to practically all draft work.	Can not work efficiently in hot or sultry weather.
Fairly good traction in wet or loose ground.	Working speed limited.
Lay up of one animal does not lay up entire power plant.	Not efficient for stationary work.
Can be reproduced on farm.	Relatively large amount of time required to feed, harness, and care for.
Do not require constant attention in guiding.	Require a relatively large space for shelter and feed storage.
Relatively cheap type of power in areas where a surplus of both grain and roughage is produced.	Unwieldy when used in large units.
	Require the products from one-fourth of all crop land to feed them.

ADVANTAGES—continued

Gas tractor:
- Can work continuously at heavy loads.
- Not affected by hot weather.
- Adapted both for stationary and for most draft work.
- Great range of working speeds.
- No attention required when not in use.
- Requires no feed or fuel when not in use. (Applies to all mechanical power.)
- Quickly available when needed in an emergency.

Stationary gas engines:
- Has practically the same advantages and disadvantages as the gas tractor as applied to stationary work. Its special advantage over the electric motor is its greater portability.

Steam engines:
- Great overload capacity.
- Smoothness and flexibility of operation.
- Adapted for both draft and stationary work.
- Uses fairly cheap fuel.
- Usually a cheap type of power when used in large units.

Windmill:
- Cheapness when used direct.
- Requires little attention when in use.
- Requires no attention when not in use.

Electric motor:
- Extreme convenience in operation.
- Requires little attention when in use.
- Requires practically no attention when not in use.
- Considerable overload capacity.
- Adapted to practically all kinds of belt work.
- Especially adapted to direct-coupled power installations.
- Electricity may be used for heating and lighting as well as power.

Water power:
- Operating cost very low as a rule.
- Convenient type of power for generating electricity and for all direct power when suitably located.

DISADVANTAGES—continued

Gas tractor:
- Limited overload capacity.
- Poor traction in wet or loose ground.
- Not adapted to all kinds of draft and field work as now constructed and requires other kinds of power to supplement it under some conditions. (Same applies to all forms of mechanical power.)
- Requires mechanical skill for successful operation.
- Inflexibility of size of power unit for economical power production under some conditions. (Same applies to all forms of mechanical power.)

Stationary gas engines:
- Its disadvantages over the electric motor are: Less convenience in starting, greater noise in operation, and greater amount of care required in keeping it in adjustment.

Steam engines:
- Requires constant attention while in use.
- Usually requires extra attendant to provide fuel and water.
- Fuel and water bulky and inconvenient.
- Loss of time while getting up steam.
- Requires special mechanical skill for successful operation.

Windmill:
- Undependability when used direct.
- Variations in wind velocity.
- Expensive when energy is stored.
- Use limited to stationary work when used directly.

Electric motor:
- Electricity expensive to distribute from central plants under low-load factors.
- Expensive to store energy from isolated plants.
- Isolated plants not efficient unless operated at near full load.
- Difficult to apply direct to draft or field work.
- Expensive if applied indirectly to draft work.

Water power:
- Use limited to local stationary work when used direct.
- Installation costs usually high when used under low heads, resulting in high fixed charges.

ADVANTAGES—continued

Motor trucks:
- Great range of speed available.
- Great time saver on good roads.
- Requires no attention when not in use.
- Quickly available when needed.

DISADVANTAGES—continued

Motor trucks:
- Poor traction on wet, loose ground.
- Use limited largely to transportation.
- Frequently not economical on short hauls.

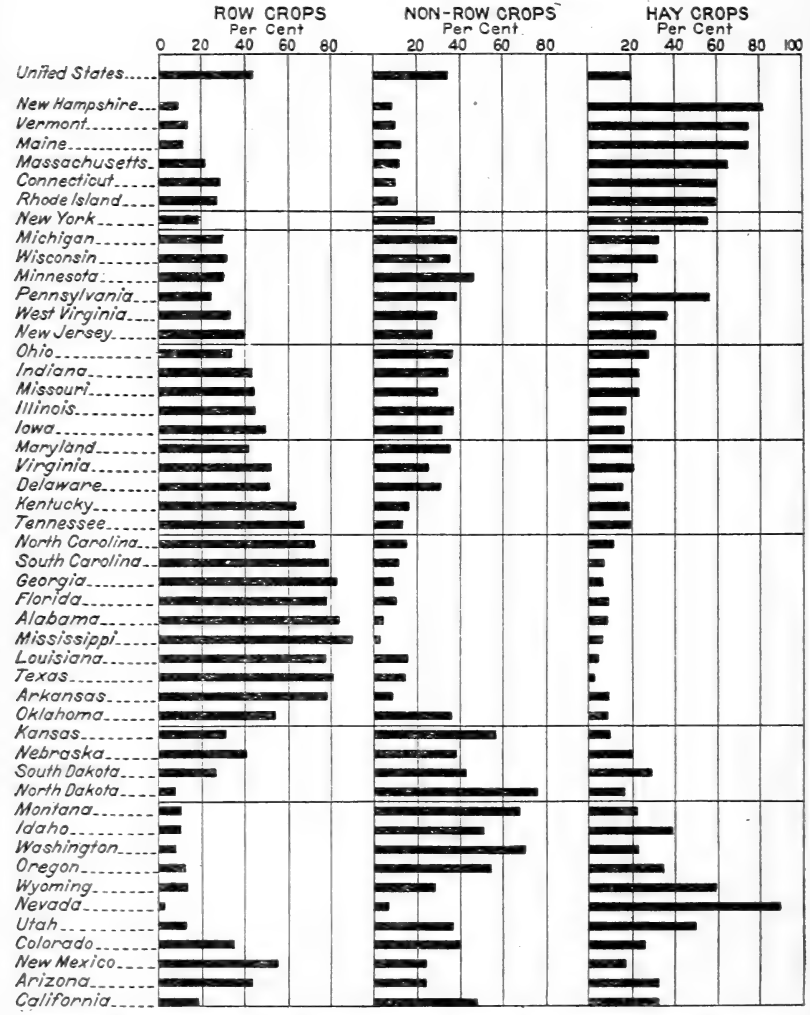

FIG. 51.—Percentage of crop area occupied by the three principal groups in 1922. Based on 1922. Crop Report of U. S. Department of Agriculture

Since approximately 50 per cent of the power utilized on farms is applied to field work, and since different field crops require different methods of power application, it is important that the type of farming followed be given particular attention in considering the choice of the kind of power to be used. For this purpose farm crops may

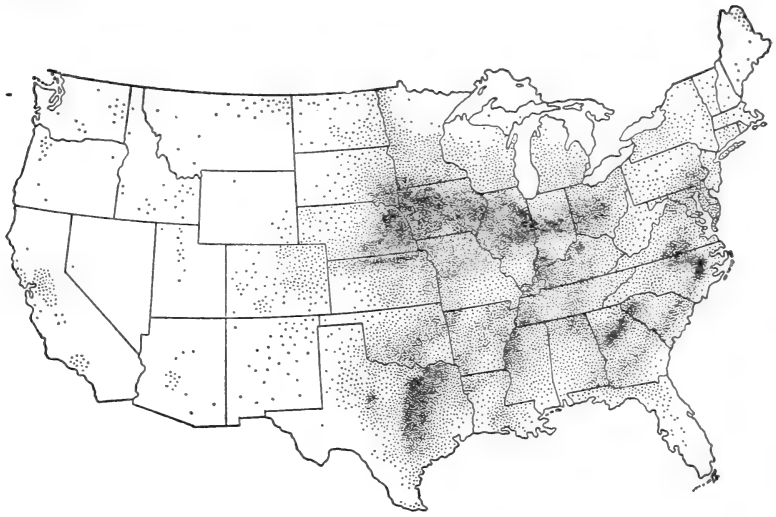

FIG. 52.—Distribution of row crops. Each dot represents 10,000 acres. Row crops include corn, cotton, tobacco, sugar beets, sugar cane, potatoes, vegetables, broomcorn, sorghum, peanuts, beans, etc., grown in rows. (Based on 1922 Crop Report of U. S. Department of Agriculture)

in general be divided into three principal groups: Row crops, nonrow crops, and hay crops.

The majority of farm implements used for field work originally were developed for the use of animal power, and this type of power can now be used successfully in doing practically all field operations. When tractors came into use for field work they were easily

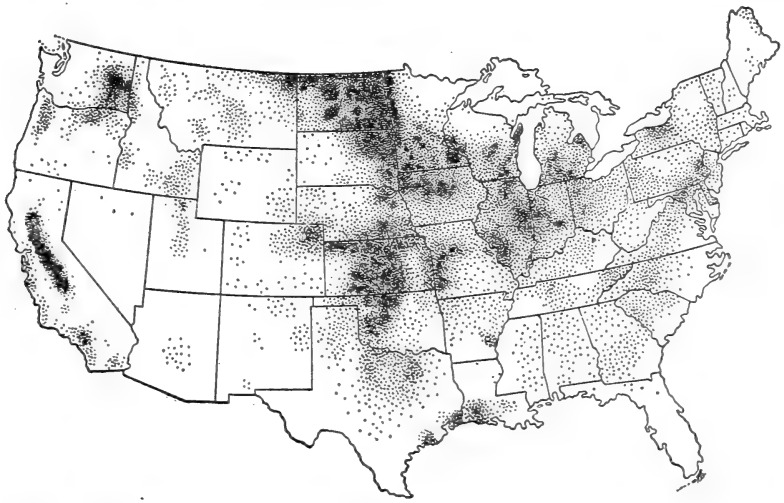

FIG. 53.—Distribution of nonrow crops. Each dot represents 10,000 acres. Nonrow crops include wheat, oats, rye, barley, rice, flax, buckwheat, fruit, nuts, etc. Fruit and nuts have been included in the nonrow crop group because the rows are far enough apart to go between the rows with practically all classes of machinery. (Based on 1922 Crop Report of U. S. Department of Agriculture)

adapted to the majority of the operations used on nonrow crops, but in the case of row and hay crops, this has proven more difficult and special equipment has had to be developed in many cases. This circumstance has tended to retard the use of the tractor where these types of farming prevail, except on the larger farms where it is easier to utilize a combination of both tractor and animal power economically. Figures 51 to 54 show the proportion and distribution of each of these three types of farming in the United States.

The cost per unit of power developed probably is the most variable of the factors affecting the choice of power in different parts of the United States. This is particularly true of animal power, owing to the use of rather bulky feeds which are expensive to transport and which, as a result, are relatively cheap in those areas where an excess is produced and relatively expensive in the areas where it is necessary to ship in a part of the amount required. The result is

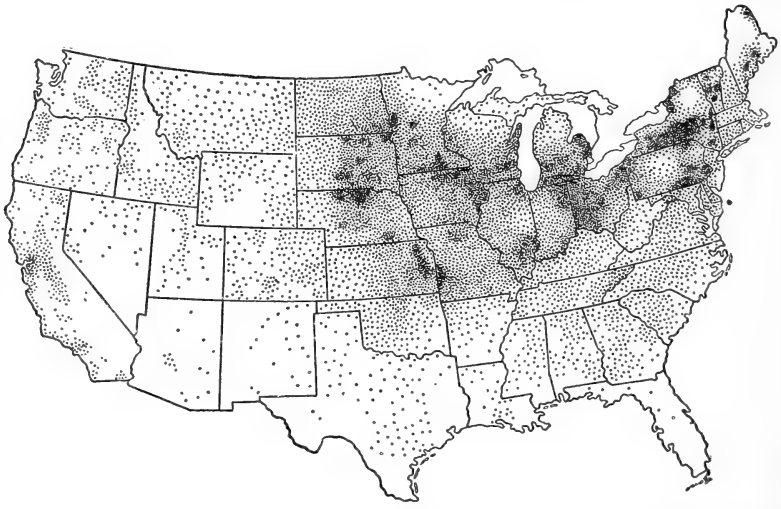

FIG. 54.—Distribution of hay crop. Each dot represents 10,000 acres. Hay crops include wild and prairie hays, alfalfa, clover, timothy, millet and various small grains, and other legumes cut for hay. (Based on 1922 Crop Report of U. S. Department of Agriculture)

a corresponding variation in the cost of the power produced. Figure 55 shows the approximate average cost of animal power in several representative States as affected by these differences in costs of feed, and the graph partially explains why animal power has proved more popular than tractor power in certain of the Central Western States during the present period of deflation in farm prices.

THE FUTURE USE OF POWER ON FARMS

This bulletin has so far considered only the amount of power utilized by agriculture under present conditions, and it may be of interest to discuss briefly some of the factors that may affect the use of power in this industry in the future. Some of these factors may be itemized as follows: An increase or decrease in the total crop acreage or in the quantities of the various commodities produced; changes

in the relative proportion of the areas devoted to the different crops produced; an increase or decrease in the yields of crops; changes in the systems of handling the crops or other farm commodities; an increased displacement of human labor by power-driven equipment, including both a broader use of the equipment now available and the possible development of entirely new types of labor-saving machinery; changes in the mechanical efficiency of the types of machinery now in use; and, finally, the possible development of entirely new methods of utilizing power by agriculture, such as stimulating crop and animal growth, control of insects, and the curing of harvested crops.

Only about 19 per cent of the land area of the United States is at the present time utilized for crop production; and while most of the land that can easily be placed under cultivation is now so utilized, it has been estimated that it will be possible to increase this to per-

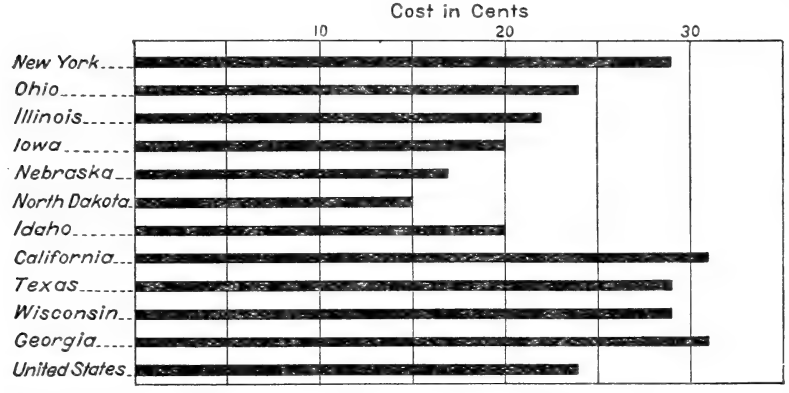

FIG. 55.—Approximate average net cost of animal power per horsepower-hour on nontractor farms in several representative States. Based on 1924 values. Includes cost of feed and housing, interest on investment, taxes, insurance, depreciation, and wages of caretaker when not actually at work. Those States showing costs below the average usually have an excess production of feeds fed to work animals, whereas in those States showing higher than the average costs it is usually necessary to ship in a part of the feed used. The value of work animals is also relatively higher as a rule in the last-mentioned States.

haps 50 per cent of the total area should the population increase to the point where the need for food would render it necessary. (See article entitled "Land Utilization" in the Yearbook of the United States Department of Agriculture, 1923.) Since about 90 per cent of the power now utilized on farms is applied either directly or indirectly to crop production, any increase in the crop area will have a corresponding tendency to increase the amount of power used.

Present available information would indicate that power equipment is utilized to replace human labor in but little over one-half of the work now done on farms. Power equipment is available for a considerable part of the remaining work but for various reasons is not now utilized. In some areas wages have been so low that it has been more economical to hire human labor than to use the available machinery; in other cases the reason has been that machinery can not or has not been developed to do the work economically where only a small amount is to be done or the proper kind of power and

the proper means of applying the power have not been available to do the work efficiently. This is particularly true of household work. In still other instances the reason is probably a lack of knowledge of the economic value of the machinery, and as this is better understood and as farm wages increase it may be expected that more and more power will be used to replace human effort. New types of machinery to replace human effort with power may also be expected to be developed and will by this means increase the amount of power used.

Little study or investigation has so far been given to the improvement of the mechanical efficiency of the machinery now used, or even to determine whether the equipment as now designed will complete the operation or operations for which it is used with the least input of power. The small amount of investigational work of this nature already done would indicate that there exist great possibilities of cutting down the amount of power used and thereby the cost of power.

Enough information is now available to indicate that many possibilities exist for utilizing power to stimulate plant and animal growth, for the control of insects, and for the curing of various crops; but many details will necessarily have to be worked out before these processes can be extensively utilized in a commercial way.

APPENDIX I

TABLE I.—*Estimated number of power units or installations on farms in the United States, January 1, 1924, and number of agricultural workers reported January 1, 1920, by the Bureau of the Census*

State	Horses [1]	Mules [1]	Tractors [2]	Trucks [2]	Stationary engines [2]	Electric power [2]	Workers [3]
Maine	84,000		800	3,000	18,000	8,000	61,139
New Hampshire	34,000		300	2,000	7,000	4,000	25,425
Vermont	70,000		600	1,500	15,000	4,500	41,757
Massachusetts	45,000		1,000	9,000	14,000	7,000	51,144
Rhode Island	6,000		100	800	2,000	600	7,615
Connecticut	35,000		700	4,000	9,000	5,500	36,459
New York	480,000	6,000	16,000	23,000	118,000	22,000	305,103
New Jersey	69,000	6,000	2,000	9,000	18,000	4,500	58,081
Pennsylvania	457,000	49,000	16,000	23,000	114,000	30,000	275,773
Delaware	24,000	9,000	400	700	5,000	600	17,362
Maryland	123,000	30,000	2,400	7,000	20,000	5,000	90,530
Virginia	262,000	88,000	4,500	6,000	35,000	11,000	291,701
West Virginia	145,000	13,000	2,000	2,500	13,000	4,000	118,999
North Carolina	157,000	250,000	5,000	6,500	38,000	10,000	468,605
South Carolina	67,000	209,000	3,500	4,500	34,000	6,000	418,485
Georgia	84,000	363,000	4,000	8,000	44,000	6,800	601,721
Florida	34,000	42,000	3,000	4,000	10,000	3,300	107,344
Kentucky	330,000	234,000	3,000	4,000	34,000	9,000	391,621
Tennessee	270,000	276,000	3,000	3,500	37,000	4,800	395,404
Alabama	117,000	302,000	2,000	3,000	24,000	4,500	497,718
Mississippi	188,000	290,000	2,500	2,500	29,000	3,000	498,380
Louisiana	150,000	173,000	5,000	2,000	23,000	3,000	278,765
Arkansas	196,000	299,000	3,000	2,500	31,000	3,500	402,080
Texas	882,000	786,000	20,000	13,000	107,000	15,000	787,700
Oklahoma	542,000	266,000	12,000	5,000	56,000	5,400	312,986
Ohio	694,000	26,000	30,000	18,000	100,000	44,000	356,617
Indiana	614,000	73,000	20,000	10,000	89,000	18,000	291,445
Illinois	1,030,000	114,000	35,000	16,000	155,000	24,000	376,625
Michigan	541,000	5,000	12,000	12,000	85,000	14,000	271,330
Wisconsin	580,000	4,000	17,000	10,000	116,000	20,000	292,264
Minnesota	773,000	8,000	23,000	10,000	126,000	8,000	291,180
Iowa	1,067,000	59,000	32,000	22,000	215,000	30,000	324,004
Missouri	749,000	243,000	14,000	12,000	96,000	10,000	391,921
North Dakota	648,000	6,000	20,000	2,000	80,000	6,000	119,755
South Dakota	603,000	10,000	20,000	9,000	78,000	6,000	116,698
Nebraska	742,000	80,000	18,000	16,000	106,000	12,000	186,579
Kansas	795,000	186,000	30,000	12,000	108,000	9,000	231,779
Montana	489,000	8,000	13,000	3,000	38,000	2,000	81,759
Wyoming	144,000	2,000	2,000	1,500	8,000	1,200	25,554
Colorado	320,000	25,000	8,000	7,500	35,000	5,000	98,842
New Mexico	146,000	17,000	800	1,500	7,000	700	54,046
Arizona	105,000	10,000	1,500	1,500	6,000	800	35,364
Utah	102,000	2,000	1,000	1,500	10,000	4,400	43,035
Nevada	38,000	1,000	400	500	3,000	400	8,431
Idaho	215,000	6,000	4,000	2,000	27,000	8,000	67,135
Washington	191,000	18,000	5,000	8,000	38,000	26,000	100,775
Oregon	188,000	10,000	5,500	5,000	29,000	9,500	78,753
California	291,000	50,000	25,000	25,000	90,000	60,000	259,709
United States	15,916,000	4,654,000	450,000	356,000	2,500,000	500,000	10,645,497

[1] Based on reports of Bureau of Agricultural Economics on horses and mules two years old or older.
[2] Estimated from manufacturers' figures and assessors' reports from several States.
[3] Reported Jan. 1, 1920, by the Bureau of the Census and corrected to exclude those engaged in lumbering and fishing but listed as agricultural workers.

TABLE II.—*Estimated primary horsepower on farms in the United States, January 1, 1924*

State	Work animals	Tractors	Motor trucks	Stationary engines, windmills, and electric power	Total
	Horsepower	*Horsepower*	*Horsepower*	*Horsepower*	*Horsepower*
Maine	100,000	19,000	56,000	64,000	239,000
New Hampshire	40,000	7,000	36,000	32,000	115,000
Vermont	75,000	14,000	31,000	57,000	177,000
Massachusetts	47,000	20,000	177,000	63,000	307,000
Rhode Island	6,000	3,000	20,000	7,000	36,000
Connecticut	36,000	14,000	80,000	45,000	175,000
New York	486,000	277,000	460,000	418,000	1,641,000
New Jersey	75,000	34,000	169,000	70,000	348,000
Pennsylvania	500,000	240,000	469,000	411,000	1,620,000
Delaware	31,000	10,000	15,000	16,000	72,000
Maryland	153,000	57,000	140,000	66,000	416,000
Virginia	335,000	101,000	127,000	140,000	703,000
West Virginia	155,000	32,000	48,000	51,000	286,000
North Carolina	326,000	82,000	134,000	137,000	679,000
South Carolina	223,000	92,000	87,000	117,000	519,000
Georgia	370,000	94,000	157,000	158,000	779,000
Florida	58,000	47,000	80,000	45,000	230,000
Kentucky	470,000	77,000	77,000	139,000	763,000
Tennessee	440,000	93,000	72,000	123,000	728,000
Alabama	308,000	47,000	59,000	85,000	499,000
Mississippi	347,000	53,000	50,000	93,000	543,000
Louisiana	247,000	104,000	44,000	125,000	520,000
Arkansas	381,000	70,000	52,000	150,000	653,000
Texas	1,345,000	490,000	270,000	470,000	2,575,000
Oklahoma	703,000	328,000	108,000	202,000	1,341,000
Ohio	800,000	390,000	366,000	448,000	2,004,000
Indiana	706,000	356,000	184,000	322,000	1,568,000
Illinois	1,190,000	840,000	308,000	533,000	2,871,000
Michigan	594,000	300,000	244,000	293,000	1,431,000
Wisconsin	640,000	385,000	202,000	402,000	1,629,000
Minnesota	853,000	614,000	190,000	395,000	2,052,000
Iowa	1,222,000	770,000	445,000	727,000	3,164,000
Missouri	913,000	362,000	253,000	314,000	1,842,000
North Dakota	702,000	676,000	40,000	270,000	1,688,000
South Dakota	635,000	520,000	217,000	264,000	1,636,000
Nebraska	845,000	481,000	327,000	387,000	2,040,000
Kansas	975,000	834,000	196,000	404,000	2,409,000
Montana	535,000	314,000	62,000	147,000	1,058,000
Wyoming	157,000	46,000	30,000	34,000	267,000
Colorado	350,000	190,000	150,000	136,000	826,000
New Mexico	138,000	20,000	25,000	39,000	222,000
Arizona	108,000	31,000	28,000	47,000	214,000
Utah	109,000	26,000	28,000	66,000	229,000
Nevada	39,000	8,000	9,000	12,000	68,000
Idaho	232,000	74,000	42,000	240,000	588,000
Washington	230,000	134,000	164,000	226,000	754,000
Oregon	214,000	122,000	92,000	140,000	568,000
California	356,000	602,000	500,000	870,000	2,328,000
United States	19,800,000	10,500,000	7,120,000	10,000,000	47,420,000

TABLE III.—*Estimated total horsepower-hours developed annually on farms in the United States*

[Expressed in thousands of horsepower-hours]

State	Work animals	Tractors	Motor trucks	Stationary engines, windmills, and electric power	Total
Maine	53,000	5,000	5,000	12,000	75,000
New Hampshire	21,000	2,000	3,000	7,000	33,000
Vermont	38,000	3,000	2,000	13,000	56,000
Massachusetts	25,000	5,000	16,000	15,000	61,000
Rhode Island	3,000	1,000	2,000	2,000	8,000
Connecticut	20,000	4,000	7,000	10,000	41,000
New York	264,000	68,000	40,000	96,000	468,000
New Jersey	40,000	8,000	16,000	16,000	80,000
Pennsylvania	250,000	59,000	40,000	95,000	444,000
Delaware	16,000	3,000	1,000	4,000	24,000
Maryland	77,000	13,000	14,000	15,000	119,000
Virginia	170,000	24,000	10,000	32,000	236,000
West Virginia	83,000	8,000	4,000	12,000	107,000
North Carolina	163,000	11,000	10,000	32,000	216,000
South Carolina	117,000	22,000	7,000	27,000	173,000
Georgia	206,000	22,000	13,000	36,000	277,000
Florida	32,000	11,000	6,000	10,000	59,000
Kentucky	236,000	18,000	6,000	32,000	292,000
Tennessee	220,000	22,000	5,000	28,000	275,000
Alabama	151,000	10,000	5,000	20,000	186,000
Mississippi	171,000	15,000	4,000	22,000	212,000
Louisiana	124,000	25,000	3,000	75,000	227,000
Arkansas	182,000	18,000	4,000	64,000	268,000
Texas	590,000	118,000	20,000	145,000	873,000
Oklahoma	319,000	78,000	9,000	46,000	452,000
Ohio	410,000	96,000	32,000	103,000	641,000
Indiana	362,000	86,000	16,000	74,000	538,000
Illinois	628,000	200,000	30,000	135,000	993,000
Michigan	320,000	72,000	20,000	68,000	480,000
Wisconsin	347,000	92,000	18,000	92,000	549,000
Minnesota	432,000	148,000	16,000	91,000	687,000
Iowa	650,000	187,000	36,000	167,000	1,040,000
Missouri	445,000	87,000	20,000	72,000	624,000
North Dakota	320,000	162,000	3,000	63,000	548,000
South Dakota	289,000	125,000	17,000	60,000	491,000
Nebraska	400,000	115,000	26,000	90,000	631,000
Kansas	438,000	200,000	20,000	96,000	754,000
Montana	200,000	75,000	5,000	40,000	320,000
Wyoming	49,000	11,000	3,000	8,000	71,000
Colorado	150,000	46,000	12,000	36,000	244,000
New Mexico	29,000	5,000	2,000	75,000	111,000
Arizona	21,000	8,000	3,000	21,000	53,000
Utah	44,000	6,000	3,000	20,000	73,000
Nevada	13,000	2,000	1,000	3,000	19,000
Idaho	106,000	18,000	3,000	70,000	197,000
Washington	143,000	46,000	14,000	80,000	283,000
Oregon	119,000	40,000	8,000	45,000	212,000
California	214,000	200,000	40,000	725,000	1,179,000
United States	9,700,000	2,600,000	600,000	3,100,000	16,000,000

TABLE IV.—*Estimated average primary horsepower per worker and per farm, average horsepower-hours utilized annually per worker, per farm, and per improved acre, and horsepower-hours of power utilized per hour of human labor*

State	Average primary horsepower		Average horsepower-hours utilized annually			
	Per worker	Per farm	Per worker	Per farm	Per improved acre	Per hour of human labor
Maine	4.0	5.0	1,230	1,550	38	0.41
New Hampshire	4.5	5.6	1,300	1,600	47	.44
Vermont	4.2	6.1	1,340	1,920	33	.45
Massachusetts	6.0	9.6	1,190	1,900	67	.40
Rhode Island	4.7	8.9	1,050	1,950	60	.35
Connecticut	5.0	7.8	1,120	1,810	58	.37
New York	5.4	8.5	1,530	2,420	36	.51
New Jersey	6.0	11.7	1,380	2,690	51	.46
Pennsylvania	5.9	8.0	1,600	2,200	37	.53
Delaware	4.2	7.1	1,380	2,380	36	.46
Maryland	4.6	8.7	1,320	2,480	38	.44
Virginia	2.4	3.8	810	1,270	25	.27
West Virginia	2.5	3.2	900	1,230	19	.30
North Carolina	1.4	2.5	460	800	26	.16
South Carolina	1.3	2.7	410	900	28	.14
Georgia	1.3	2.5	460	890	21	.15
Florida	2.2	4.4	550	1,100	26	.18
Kentucky	2.0	2.9	750	1,080	21	.25
Tennessee	1.9	3.0	700	1,090	25	.23
Alabama	1.0	2.0	380	730	19	.12
Mississippi	1.1	2.0	420	780	23	.14
Louisiana	1.9	4.0	810	1,690	40	.27
Arkansas	1.6	2.8	670	1,150	29	.22
Texas	3.3	6.0	1,110	2,000	28	.37
Oklahoma	4.3	7.0	1,450	2,350	25	.48
Ohio	5.6	7.8	1,800	2,500	35	.60
Indiana	5.4	7.7	1,850	2,620	32	.62
Illinois	7.6	12.1	2,640	4,180	36	.88
Michigan	5.3	7.3	1,770	2,450	37	.59
Wisconsin	5.6	8.6	1,880	2,900	44	.63
Minnesota	7.0	11.5	2,360	3,860	32	.78
Iowa	9.8	14.8	3,210	4,880	36	1.07
Missouri	4.7	7.0	1,600	2,370	25	.53
North Dakota	14.1	21.8	4,580	7,070	22	1.52
South Dakota	14.1	22.0	4,210	6,570	27	1.43
Nebraska	11.0	16.4	3,380	5,070	27	1.13
Kansas	10.4	14.6	3,250	4,560	25	1.08
Montana	13.0	18.4	3,920	5,550	29	1.37
Wyoming	10.4	17.0	2,780	4,500	34	.93
Colorado	8.4	13.8	2,470	4,080	32	.82
New Mexico	4.1	7.4	2,060	3,720	65	.69
Arizona	6.1	21.4	1,500	5,320	74	.50
Utah	5.4	9.0	1,690	2,840	42	.56
Nevada	8.1	21.5	2,260	6,000	32	.75
Idaho	8.8	14.0	2,940	4,680	44	.98
Washington	7.4	11.4	2,800	4,270	40	.93
Oregon	7.2	11.3	2,700	4,220	43	.90
California	8.9	19.8	4,540	10,000	100	1.51
United States	4.5	7.4	1,500	2,480	32	.50

TABLE V.—*Approximate power required for farm operations*

[The data contained in this table are based on averages from all information available. Special acknowledgment is due F. N. G. Kranich for a most complete list of the power requirements for the larger farm operations]

FIELD OPERATIONS

Operation	Conditions	Draft, in pounds, per foot of width covered	Horsepower-hours per acre
Plowing 6 inches deep	Sandy loam	200–400	4.5–9
Do	Sandy clay loam	350–500	8–11
Do	Clay loam	400–600	9–13
Do	Heavy clay	600–1,000	13–22
Do	Gumbo	1,000–1,500	22–33
Peg-tooth harrow	Average	15–60	.3–1.3
Spring-tooth harrow	do	25–70	.5–1.5
Disk harrow (single)	do	50–100	1.1–2.2
Do	Heavy clay	100–150	2.2–3.3
Land roller	Average soil	20–80	.4–2.0
Drilling grain	do	20–80	.4–1.8
Mowing hay	do	35–70	.75–1.5
Raking:			
Dump rake	do	15–25	.3–.6
Side-delivery	do	20–40	.4–.9
Hay loader (and wagon)	do	50–100	1.1–2.2
Binding grain	do	60–100	1.3–2.2
Heading grain	do	50–80	1.1–1.8
Header-thresher (independent engine)	do	90–180	2.0–4.0
Header-thresher (bull-wheel drive)	do	150–300	3.0–6.5
		Pounds per row	
Corn planter	do	100–300	.6–2.5
Corn lister	do	300–600	2.0–4.0
Corn cultivator	do	130–300	.8–2.5
Corn binder	do	350–700	2.5–5.0
Corn picker	do	1,000–1,800	6.5–12.0
Potato digger	do	600–1,000	5.0–7.5
Stalk cutter	do	130–250	.8–2.0

HAULING [1]

Roadbed	Draft, in pounds, per ton of gross load	Horsepower-hours per ton-mile of gross load
Concrete pavement	20–30	0.05–0.08
Waterbound macadam	60–80	.15–.20
Gravel (good condition)	80–100	.2–.25
Earth (dry and firm)	80–100	.2–.25
Hay stubble (dry)	100–200	.25–.50
Corn stubble (dry)	150–300	.40–.80
Plowed ground	300–500	.80–1.3

BELT OPERATIONS

Operation	Unit	Horsepower-hours per unit
Threshing wheat or rye	100 bushels	20–40
Threshing oats or barley	do	10–25
Threshing peas or beans	do	20–40
Hulling alfalfa or clover	do	100–300
Shredding corn	do	20–40
Shelling corn	do	4–8
Cleaning grain	do	2–10
Elevating grain	do	.2–.5
Grinding feed	do	10–30
Cutting silage or feed	Ton	.9–2.5
Baling hay or straw	do	2–6
Pumping water (large pumps)	1,000 gallon-feet	.007–.015

[1] See Tables XXII and XXIII for farm tonnage hauled and the average length of haul and Table XXIV for pounds pull exerted per drawbar horsepower for various speeds of travel.

TABLE VI.—*Approximate power required to operate small machines used on the farm*

[The quantity of power required in the operations appearing in this table have not been given because the conditions met with vary so greatly and also because of the varying conditions under which the power is applied. In many cases more power is required in the transmission of the power to the machine used than in the operating of the machine itself]

Device	Usual range	Most common size	Device	Usual range	Most common size
	Horse-power	*Horse-power*		*Horse-power*	*Horse-power*
Washing machine	1/8–1 1/2	1/4	Horse and sheep clippers	1/6– 1/2	1/4
Vacuum cleaner	1/8– 1/2	1/8	Grindstone	1/8– 1/2	1/4
Sewing machine	1/10– 1/10	1/10	Milking machine	1/8– 5	1 1/2
Dish-washing machine	1/8– 1/4	1/4	Emery wheel	1/8– 1	1/4
Ironing machine	1/8– 1/2	1/4	Lathe	1/4– 1	1/2
Ice-cream freezer	1/4–1	1/2	Concrete mixer	1 – 5	2 1/2
Separator (cream)	1/8– 1/4	1/6	Refrigeration	1/8–10	1/4
Churn	1/8–3	1/4	Cordwood saw	3 –10	5
Milk tester	1/8– 1/8	1/8	Water pump	1/4– 5	1 1/2
Root cutter	1/4–1	1/4	Spray pump	1 – 4	2 1/2

TABLE VII.—*Summary of work factors for operations with field implements in the United States* [1]

Operation or implement	Power unit (number of horses)	Daily duty per foot of width [2]	Range of reported widths	Most usual width per horse
		Acres		*Feet*
Walking plow	2	1.7	8 to 14 inches	0.50
Do	3	2.1	10 to 16 inches	.44
Sulky plow	2	1.7	do	.58
Do	3	2.2	12 to 16 inches	.44
Do	4	2.3	14 to 18 inches	.33
Gang plow	4	2.2	18 to 28 inches	.58
Do	5	2.3	24 to 28 inches	.47
Do	6	2.3	24 to 32 inches	.39
Spike-tooth harrow:				
On fresh plowing	2	1.5	6 to 12 feet	4.00
On well-packed land		1.7		
On fresh plowing	3	1.6	8 to 16 feet	3.50
On well-packed land		1.9		
On fresh plowing	4	1.8	10 to 26 feet	4.25
On well-packed land		2.1		
Spring-tooth harrow:				
On fresh plowing	2	1.2	4 to 8 feet	3.00
On well-packed land		1.5		
On fresh plowing	3	1.4	5 to 10 feet	2.33
On well-packed land		1.7		
On fresh plowing	4	1.6	6 to 12 feet	2.00
On well-packed land		1.8		
Disk harrow:				
On fresh plowing	2	1.1	4 to 8 feet	3.00
On well-packed land		1.2		
On fresh plowing	3	1.2	6 to 10 feet	2.25
On well-packed land		1.6		
On fresh plowing	4	1.7	do	2.00
On well-packed land		2.0		
Land roller	2	1.7	5 to 12 feet	4.00
Do	3	1.7	do	2.00
Do	4	1.8	8 to 16 feet	2.50
Grain drill	2	1.46	4 to 8 feet	3.25
Do	3	1.56	6 to 10 feet	2.50
Do	4	1.82	6 to 12 feet	2.25
Do	6	1.98	8 to 12 feet	1.75
Corn or cotton planter:				
1-row	1	2.28	36 to 48 inches between rows	3.50
Do	2	3.10	do	1.50
2-row	2	1.9	do	3.5
Covering seed potatoes	1	2.10	24 to 32 inches between rows	2.00
Do	2	2.62	do	2.33
Marking planting rows	1	1.57	3 to 12 feet	3.00
Do	2	2.10	do	6.00

[1] Based on data in Yearbook Separate 890, U. S. Department of Agriculture, 1922.
[2] Ten-hour day.

TABLE VII.—*Summary of work factors for operations with field implements in the United States*—Continued

Operation or implement	Power unit (number of horses)	Daily duty per foot of width	Range of reported widths	Most usual width per horse
		Acres		*Feet*
Potato planter:				
1-man	2	2.47	24 to 32 inches between rows	2.33
2-man	2	2.20	do	2.33
Lime spreader	2	1.15	6 to 12 feet	4.00
Fertilizer drill	2	1.36	5 to 10 feet	3.00
Do	3	1.46	6 to 12 feet	2.66
Field sprayer	1	1.15	3 to 4 rows each trip	11.00
Do	2	1.30	do	6.00
Mowing hay	2	1.68	4 to 7 feet	2.50
Raking hay	1	1.78	6 to 12 feet	9.00
Do	2	1.90	8 to 16 feet	6.00
Tedding hay	1	1.69	6 to 8 feet	7.00
Do	2	2.06	6 to 10 feet	4.25
Grain binder	3	1.79	4 to 7 feet	2.00
Do	4	2.08	5 to 8 feet	2.00
Do	5	2.18	do	1.66
Grain header	4	2.03	10 to 12 feet	3.00
Do	5	2.13	do	2.25
Do	6	2.23	12 to 14 feet	2.33
Corn binder	3	2.09	Rows 36 to 48 inches (average yields)	1.50
Cultivating	1	2.5		
Do	2	2.0		
Knapsack sprayer		1.04		
Wheelbarrow seed sower		1.45	10 to 16 feet	
Hand corn planter		1.34	36 to 48 inches between rows	

TABLE VIII.—*Approximate average man-hour of labor per acre required for crop production in various parts of the United States*

[The data contained in this table were secured partly from estimates made by the farm management departments of a number of the State agricultural colleges, and partly from Yearbook Separate 876, U. S. Department of Agriculture, and other farm management studies]

Area	Corn for grain [1]	Corn for silage	Small grain cut with binder [2]	Small grain cut with combine [2]	Hay, per cutting [3]	Potatoes	Tobacco	Cotton [4]	Rice	Sugar beets	Truck crops	Fruit	Cowpeas and soy beans [2]
New England	100	100	42		10	100							
New York	66	58	24		10	100						170	42
New Jersey	69				10	100					190		
Pennsylvania	50	49	24		12	106							
Virginia	50		23			82							
West Virginia	57	57	23		8		378						
Kentucky	46	60	12				363						18
South Carolina					11	116		136					
Georgia	40		15		20	115	400	125					19
Louisiana	37	48			12	137		100	37				
Arkansas	38	48	16		16	94		112	46			140	
Texas					16	47		64	37				
Missouri	24	30	15										25
Ohio	48	51	20		10	120	300			110	150		
Michigan	30	32	19			80				110			40
Wisconsin	30	30	15		14	82						140	32
Minnesota	26	32	12		12	58				155			
Indiana	26	30	15		12								
Illinois	20	28	15		8.4								
Iowa	18	28			7.5	69							
Kansas	16	26	8.5	5	4								
Eastern Nebraska	16	26	10		6								
Western Nebraska	12	23	7	5	5								
Dakotas	13	23	7		8	32							
Colorado, dry			7	5	5								
Colorado, irrigated			25		12	75				124		352	41
Utah, irrigated					13	114				129			
Northwest, irrigated			24		15					119		400	30
Northwest, dry			17	7									

[1] Does not include shelling or marketing.
[2] Does not include marketing.
[3] Does not include baling or marketing.
[4] Does not include ginning.

TABLE IX.—*Approximate average power, in horsepower-hours per acre, required for crop production in various parts of the United States*

[The figures contained in this table are based partly on the same sources as the data contained in Table VIII and partly on Table V of this bulletin, with some allowances made for variations in climate and types of soil in the various States]

Area	Corn for grain [1]	Corn for silage	Small grain cut with binder [2]	Small grain cut with combine [2]	Hay, per cutting [3]	Potatoes	Tobacco	Cotton [4]	Rice	Sugar beets	Truck crops	Fruit	Cowpeas and soy beans [2]
New England	35	50	21	------	5	50	------	------	------	------	------	45	31
New York	27	42	23	------	5	50	------	------	------	------	------	------	------
New Jersey	27	42	------	------	6	50	------	------	------	------	------	------	------
Pennsylvania	27	42	22	------	------	54	------	------	------	------	------	------	------
Virginia	30	45	------	------	------	35	------	------	------	------	------	------	------
West Virginia	30	45	20	------	4	42	27	------	------	------	------	------	------
Kentucky	30	45	15	------	4	------	44	------	------	------	------	------	15
South Carolina	------	------	------	------	------	33	------	30	------	------	------	------	------
Georgia	22	------	16	------	12	30	45	30	------	------	------	------	13
Louisiana	26	41	23	------	10	42	------	20	38	------	------	------	------
Arkansas	26	41	23	------	9	32	------	26	42	------	40	45	------
Texas	------	------	------	------	------	27	------	20	40	------	------	------	------
Missouri	24	39	18	------	------	------	------	------	------	------	------	------	20
Ohio	30	45	20	------	6	50	50	------	------	40	------	------	25
Michigan	30	45	20	------	------	40	------	------	------	45	40	------	25
Wisconsin	27	42	20	------	6	40	------	------	------	------	------	------	22
Minnesota	27	42	20	------	8	35	------	------	------	55	------	------	------
Indiana	30	45	20	------	------	------	------	------	------	------	------	------	------
Illinois	26	41	22	------	6	------	------	------	------	------	------	------	------
Iowa	26	41	------	------	6	43	------	------	------	------	------	------	------
Kansas	22	35	15	9	4	------	------	------	------	------	------	------	------
Eastern Nebraska	22	35	16	------	5	------	------	------	------	------	------	------	------
Western Nebraska	19	32	14	9	4	------	------	------	------	------	------	------	------
Dakotas	19	------	15	------	6	38	------	------	------	------	------	------	------
Colorado, dry	------	------	15	9	4	------	------	------	------	------	------	------	------
Colorado, irrigated	------	------	25	------	7	50	------	------	------	55	------	62	20
Utah, irrigated	------	------	------	------	6	58	------	------	------	70	------	------	------
Northwest, irrigated	------	------	25	------	7	50	------	------	------	52	------	70	------
Northwest, dry	------	------	14	9	4	------	------	------	------	------	------	------	------

[1] Does not include shelling or marketing.
[2] Does not include marketing.
[3] Does not include bailing or marketing.
[4] Does not include ginning.

TABLE X.—*Approximate average labor and power requirements for care of livestock* [1]

	Man-hours [2]	Horse-power-hours [3]		Man-hours [2]	Horse-power-hours [3]
Horses, Corn Belt States	80	4	10 hogs, Eastern States	200	10
Horses, Eastern States	120	4	10 brood sows, and raising pigs (to weaning)	300	25
Dairy cows	180	10	100 ewes	500	25
Young stock, cattle, colts, etc	25	1	100 feeding sheep, yard lots (per month)	35	15
20 feeding steers (per month)	20	8	100 chickens (well cared for)	200	10
10 hogs, Corn Belt States	100	10			

[1] Time covered in this table is for a year except as noted.
[2] Farmers' Bulletin 1139, U. S. Department of Agriculture.
[3] Based on figures in Farmers' Bulletin 1139.

TABLE XI.—*Acreage of principal crops raised in the United States in 1922*

[Yearbook of the United States Department of Agriculture, 1923. Thousands of acres]

Geographic division and State	Wheat	Oats	Barley	Rye	Flax and buck-wheat	Rice	Fruit and nuts [1]	Corn
New England:								
Maine	4	120	3		8		96	19
New Hampshire		18	1		1		29	27
Vermont	4	90	9		4		28	85
Massachusetts		10		3	1		73	61
Rhode Island		1					8	13
Connecticut		11		5	2		36	77
Middle Atlantic:								
New York	463	1,059	158	55	208		528	798
New Jersey	77	72		61	10		94	231
Pennsylvania	1,339	1,170	12	220	225		368	1,573
East North Central:								
Ohio	2,526	1,472	73	87	25		306	3,823
Indiana	1,996	1,506	30	350	6		99	4,765
Illinois	3,196	3,860	190	256	6		152	8,819
Michigan	1,023	1,498	140	642	62		316	1,720
Wisconsin	176	2,465	443	489	29		61	2,209
West North Central:								
Minnesota	1,989	4,021	908	1,154	385		40	3,979
Iowa	731	5,874	161	55	13		77	10,364
Missouri	3,105	1,200	5	28	1		175	6,250
North Dakota	8,980	2,388	1,008	1,800	521		2	780
South Dakota	2,989	2,400	881	506	174		8	3,861
Nebraska	4,177	2,408	242	188	4		30	7,296
Kansas	9,756	1,494	1,074	71	20		61	5,098
South Atlantic:								
Delaware	109	7		6	8		37	189
Maryland	578	58	4	17	9		77	642
Virginia	830	166	9	40	18		250	1,866
West Virginia	240	200		10	33		189	604
North Carolina	600	220		60	7		149	2,577
South Carolina	165	406		6		8	35	2,062
Georgia	190	474		18		3	222	4,385
Florida		37				3	151	775
East South Central:								
Kentucky	650	234	6	20	9		147	3,145
Tennessee	472	229	14	20	3		140	3,280
Alabama	20	277		1			81	3,636
Mississippi	5	125				1	47	2,855
West South Central:								
Arkansas	78	264		1		154	132	2,250
Louisiana		56				555	25	1,706
Oklahoma	3,300	1,500	129	35			98	3,200
Texas	1,249	1,455	93	13		191	167	5,729
Mountain:								
Montana	3,618	660	92	240	84		21	228
Idaho	1,123	162	85	13			54	52
Wyoming	179	158	20	35	1		2	112
Colorado	1,620	185	186	97			43	1,145
New Mexico	105	53	9	2			17	236
Arizona	49	20	25				6	39
Utah	294	86	18	12			21	32
Nevada	21	2	6				1	1
Pacific:								
Washington	2,486	202	74	19			192	67
Oregon	1,093	267	80	37			140	69
California	712	150	1,129			140	1,011	116
United States	62,317	40,790	7,317	6,672	1,877	1,055	6,042	102,846

[1] Based on 1920 census.

TABLE XI.—*Acreage of principal crops raised in the United States in 1922*—Continued

[Yearbook of the United States Department of Agriculture, 1923. Thousands of acres]

Geographic division and State	Cotton	Potatoes [1]	Broomcorn and kafirs	Vegetables [2]	Dry beans and peanuts	Tobacco	Sugar cane and beets	All hay
New England:								
Maine		135		32				1,248
New Hampshire		14		9				462
Vermont		25		11				922
Massachusetts		29		44		9		442
Rhode Island		3		5				46
Connecticut		24		19		28		329
Middle Atlantic:								
New York		340		187	108	2		4,937
New Jersey		115		93				325
Pennsylvania		256		104		43		2,943
East North Central:								
Ohio		129	4	119		46	28	3,376
Indiana		77	11	119		18		2,725
Illinois		116	30	146				3,707
Michigan		357		126	458		106	3,130
Wisconsin		328	2	129	8	40	13	3,490
West North Central:								
Minnesota		486	2	71				4,041
Iowa		89	12	109				3,776
Missouri	198	104	42	91		5		3,654
North Dakota		210		20				3,497
South Dakota		110		32				4,675
Nebraska		139	21	38			55	3,761
Kansas		69	1,058	46				2,517
South Atlantic:								
Delaware		21		30				79
Maryland		61		119		26		410
Virginia	55	201	13	133	130	209		1,054
West Virginia		52	8	38		9		779
North Carolina	1,625	160	30	101	145	505		900
South Carolina	1,912	137	21	75	36	85	10	461
Georgia	3,418	177	30	102	160	11	50	744
Florida	118	58	1	56	72	3	29	132
East South Central:								
Kentucky		79	48	105		525		1,200
Tennessee	985	76	35	117	14	130		1,434
Alabama	2,771	190	74	68	205		79	785
Mississippi	3,014	125	42	69	18		37	499
West South Central:								
Arkansas	2,799	82	28	89	18		4	718
Louisiana	1,140	112	1	42	18	1	319	232
Oklahoma	2,915	67	1,662	46	17			1,460
Texas	11,874	144	2,021	129	172		19	872
Mountain:								
Montana		45		23				1,705
Idaho		81		15	26		33	1,161
Wyoming		22		5				1,025
Colorado		142	257	37	81		165	1,557
New Mexico		5	173	12	62			195
Arizona	101	8	30	12	7			175
Utah		21		16			80	615
Nevada		5		2				360
Pacific:								
Washington		65		37				1,014
Oregon		49		35				1,193
California	67	84	130	206	324		62	2,268
United States	[3] 33,036	5,424	5,786	3,269	2,079	1,695	[4] 1,153	77,030

[1] Potatoes and sweet potatoes.
[2] Based on 1920 census.
[3] Includes 44,000 acres in "Other States."
[4] Includes 64,000 acres in "Other States."

TABLE XII.—*Average yield per acre of the principal crops for the years 1918–1922*

[Yearbook of the United States Department of Agriculture, 1922]

State	Corn	Wheat	Oats	Barley	Rye	Rice	Potatoes	Hay	Tobacco	Cotton (lint)
	Bushels	*Bushels*	*Bushels*	*Bushels*	*Bushels*	*Bushels*	*Bushels*	*Tons*	*Pounds*	*Pounds*
Maine	47.2	21.0	37.8	26.6			213	1.07		
New Hampshire	46.5		36.6	26.8			126	1.14		
Vermont	45.7	18.4	34.9	27.6			126	1.32		
Massachusetts	46.5		34.4		19.0		111	1.31	1,457	
Rhode Island	43.0		31.8				109	1.19		
Connecticut	47.4		31.1		19.8		106	1.30	1,450	
New York	40.1	19.9	31.8	25.9	16.3		109	1.26	1,234	
New Jersey	42.8	18.0	31.4		17.7		122	1.51		
Pennsylvania	44.8	17.4	34.3	24.7	16.4		98	1.39	1,406	
Delaware	33.0	13.9	28.4		13.5		84	1.33		
Maryland	38.7	15.3	30.1	30.7	14.7		88	1.45	773	
Virginia	27.8	11.7	21.5	25.9	11.6		109	1.22	666	242
West Virginia	33.4	12.8	24.0		12.3		96	1.26	759	
North Carolina	20.4	8.6	18.9		8.5		90	1.19	634	265
South Carolina	16.5	10.2	23.4		10.4	24.6	90	.95	672	203
Georgia	14.3	9.8	20.0		9.2	25.2	71	.94	607	134
Florida	14.5		15.2			24.2	95	.95	992	84
Kentucky	26.8	11.2	21.5	26.6	11.8		78	1.19	861	
Tennessee	24.4	9.7	20.6	21.9	8.8		70	1.26	763	195
Alabama	14.7	9.5	19.4		9.7		76	.89		130
Mississippi	16.7	13.3	18.4			24.4	81	1.27		159
Louisiana	17.8		23.1			34.4	68	1.40	451	129
Arkansas	19.2	10.7	23.7		10.2	46.9	65	1.18		169
Texas	22.2	11.5	23.9	23.6	11.9	33.1	60	1.40		131
Oklahoma	20.5	12.9	25.8	22.0	12.4		62	1.53		145
Ohio	40.5	15.6	34.2	25.5	14.9		75	1.36	924	
Indiana	36.7	14.9	32.0	25.0	13.9		69	1.30	881	
Illinois	35.1	17.6	33.7	29.8	16.8		61	1.32		
Michigan	36.1	15.7	31.2	23.1	13.6		93	1.18		
Wisconsin	43.8	16.6	38.1	29.7	15.5		101	1.60	1,254	
Minnesota	38.3	12.7	33.2	24.5	17.7		91	1.62		
Iowa	42.1	18.3	35.7	27.3	17.4		72	1.45		
Missouri	27.5	13.3	24.5	25.6	12.2		67	1.14	945	283
North Dakota	26.3	10.4	23.0	18.4	11.0		85	1.26		
South Dakota	30.6	11.8	31.0	23.3	15.7		77	1.65		
Nebraska	26.1	14.2	28.0	22.8	13.4		81	1.90		
Kansas	18.1	13.6	24.1	20.1	12.3		68	2.05		
Montana	16.4	10.6	22.8	18.2	9.7		109	1.62		
Wyoming	22.2	18.8	30.6	29.6	16.0		115	1.84		
Colorado	16.7	14.2	28.7	20.5	9.6		133	2.08		
New Mexico	20.8	15.2	25.1	22.7	14.6		69	2.24		
Arizona	27.6	24.4	33.6	33.6			89	3.26		243
Utah	23.6	19.4	36.4	31.2	9.5		173	2.48		
Nevada	28.2	23.7	35.1	30.2			155	2.54		
Idaho	36.2	21.5	37.8	31.0	15.2		178	2.68		
Washington	38.2	16.6	40.6	28.4	10.9		138	2.23		
Oregon	30.3	19.3	30.0	27.9	11.5		106	2.01		
California	34.2	16.2	30.6	26.6		57.9	138	2.11		252
United States	28.4	13.8	30.6	23.9	13.8	38.7	98.7	1.48	789.9	153.1

TABLE XIII.—*Number of domestic animals on farms, by States (1920 census)*

Geographic division and State	Horses	Mules	Asses and burros	Cattle	Sheep	Goats	Swine
New England:							
Maine	94,350	444	46	300,747	119,471	476	91,204
New Hampshire	38,194	248	26	163,653	28,021	3,574	41,655
Vermont	77,231	601	27	435,480	62,756	124	72,761
Massachusetts	50,605	332	52	216,099	18,880	1,296	104,192
Rhode Island	6,540	75	11	30,519	2,736	116	12,869
Connecticut	38,125	869	25	173,764	10,842	447	61,071
Middle Atlantic:							
New York	536,171	7,323	211	2,144,244	578,726	2,580	600,560
New Jersey	72,621	5,705	17	179,459	10,471	642	139,222
Pennsylvania	505,966	55,081	236	1,545,548	508,711	2,578	1,190,951
East North Central:							
Ohio	810,692	31,626	577	1,926,823	2,102,550	4,027	3,083,846
Indiana	717,233	100,358	1,211	1,546,095	643,889	7,872	3,757,135
Illinois	1,296,852	168,274	2,554	2,788,238	637,685	9,977	4,639,182
Michigan	605,509	5,884	145	1,586,042	1,209,191	1,607	1,106,066
Wisconsin	683,364	4,284	94	3,050,829	479,991	2,484	1,596,419
West North Central:							
Minnesota	932,794	10,238	201	3,021,469	509,064	2,745	2,380,862
Iowa	1,386,522	81,520	1,141	4,557,708	1,092,095	10,526	7,864,304
Missouri	906,220	389,045	9,427	2,781,644	1,271,616	121,012	3,888,677
North Dakota	855,682	7,873	142	1,334,552	298,912	1,250	458,265
South Dakota	817,058	15,093	220	2,348,157	843,696	1,286	1,953,826
Nebraska	961,396	99,847	1,622	3,154,265	573,217	2,286	3,435,690
Kansas	1,082,827	243,332	5,116	2,975,390	361,102	6,937	1,733,202
South Atlantic:							
Delaware	27,752	9,439	12	46,509	3,220	91	38,621
Maryland	141,341	32,621	64	283,377	103,027	873	306,452
District of Columbia	311	32	-------	965	10	7	1,331
Virginia	312,465	96,830	366	909,795	342,367	7,469	941,308
West Virginia	169,148	14,981	177	587,462	509,831	7,003	305,211
North Carolina	171,436	256,569	542	644,779	90,556	23,912	1,271,270
South Carolina	77,517	220,164	247	434,097	23,581	31,774	844,981
Georgia	100,503	406,351	427	1,156,738	72,173	110,489	2,071,051
Florida	38,570	42,046	153	638,981	64,659	45,890	755,481
East South Central:							
Kentucky	382,442	292,857	2,890	1,093,453	707,845	35,045	1,504,431
Tennessee	317,921	352,510	4,480	1,161,846	364,196	73,228	1,832,307
Alabama	130,462	296,138	782	1,044,008	81,868	104,148	1,496,893
Mississippi	214,852	308,216	1,301	1,250,479	164,440	113,277	1,373,311
West South Central:							
Arkansas	251,926	322,677	3,218	1,072,966	100,159	123,800	1,378,091
Louisiana	178,756	180,115	433	804,241	129,816	91,249	850,562
Oklahoma	738,443	336,635	5,159	2,073,945	105,370	45,825	1,304,094
Texas	991,362	845,932	9,226	6,156,715	2,573,485	1,753,112	2,225,558
Mountain:							
Montana	668,723	9,462	240	1,268,516	2,082,919	1,282	167,060
Idaho	293,123	7,735	451	714,903	2,356,270	1,515	240,030
Wyoming	198,295	3,415	165	875,433	1,859,775	1,511	72,233
Colorado	420,704	31,125	3,099	1,756,616	1,813,255	28,688	449,866
New Mexico	182,686	20,369	5,937	1,300,335	1,640,475	226,862	87,906
Arizona	136,167	11,992	5,240	821,918	881,914	161,124	49,599
Utah	125,471	2,793	609	505,578	1,691,795	29,512	99,361
Nevada	50,486	2,450	771	356,390	880,580	1,123	26,645
Pacific:							
Washington	296,381	23,091	399	572,644	623,779	6,830	264,747
Oregon	271,559	14,375	737	851,108	2,002,378	133,685	266,778
California	402,407	63,419	2,265	2,008,037	2,400,151	115,759	909,272
United States	19,767,161	5,432,391	72,491	66,652,559	35,033,516	3,458,925	59,346,409

TABLE XIV.—*Population of the United States, farm population, agricultural workers, number of farms, total land area, and total land, improved land and crop land in farms, based on 1920 census* [1]

State	Total population	Farm population	Agricultural workers	Number of farms	Total land area	Land in farms		
						Total	Improved	In crops
	Thousands	*Thousands*			*Thousand acres*	*Thousand acres*	*Thousand acres*	*Thousand acres*
Maine	768	198	61,139	48,227	19,133	5,426	1,977	1,475
New Hampshire	443	76	25,425	20,523	5,780	2,604	703	518
Vermont	353	125	41,757	29,075	5,839	4,236	1,692	1,151
Massachusetts	3,852	119	51,144	32,001	5,145	2,494	909	622
Rhode Island	604	15	7,615	4,083	683	332	133	67
Connecticut	1,381	93	36,459	22,655	3,085	1,899	701	532
New York	10,385	801	305,103	193,195	30,499	20,633	13,159	8,345
New Jersey	3,156	144	58,081	29,702	4,809	2,283	1,556	1,138
Pennsylvania	8,720	948	275,773	202,250	28,692	17,657	11,848	8,178
Delaware	223	51	17,362	10,140	1,258	944	653	487
Maryland	1,450	279	90,530	47,908	6,362	4,758	3,137	2,291
Virginia	2,309	1,065	291,701	186,242	25,768	18,561	9,460	4,871
West Virginia	1,464	478	118,999	87,289	15,374	9,570	5,520	2,246
North Carolina	2,559	1,501	468,605	269,763	31,194	20,022	8,198	7,443
South Carolina	1,684	1,075	418,485	192,693	19,517	12,426	6,184	7,053
Georgia	2,896	1,685	601,721	310,732	37,584	25,441	13,055	12,317
Florida	969	282	107,344	54,005	35,111	6,047	2,297	1,430
Kentucky	2,417	1,305	391,621	270,626	25,716	21,613	13,976	6,684
Tennessee	2,338	1,272	395,404	252,774	26,680	19,511	11,185	6,951
Alabama	2,348	1,336	497,718	256,099	32,818	19,577	9,893	9,953
Mississippi	1,791	1,271	498,380	272,101	29,672	18,197	9,326	7,958
Louisiana	1,799	786	278,765	135,463	29,062	10,020	5,626	4,944
Arkansas	1,752	1,147	402,080	232,604	33,616	17,457	9,211	7,050
Texas	4,663	2,278	787,700	436,033	167,935	114,020	31,228	25,918
Oklahoma	2,028	1,017	312,986	191,988	44,425	31,952	18,125	14,267
Ohio	5,759	1,139	356,617	256,695	26,074	23,516	18,542	11,814
Indiana	2,930	907	291,445	205,126	23,069	21,063	16,680	12,122
Illinois	6,485	1,098	376,625	237,181	35,867	31,975	27,295	21,020
Michigan	3,669	849	271,330	196,447	36,787	19,033	12,926	9,068
Wisconsin	2,632	920	292,264	189,295	35,364	22,148	12,452	9,622
Minnesota	2,387	897	291,180	178,478	51,749	30,222	21,482	15,911
Iowa	2,404	985	324,004	213,439	35,575	33,475	28,607	21,637
Missouri	3,404	1,211	391,921	263,004	43,985	34,775	24,833	15,511
North Dakota	647	395	119,755	77,690	44,917	36,215	24,563	17,648
South Dakota	637	362	116,698	74,637	49,195	34,636	18,199	15,284
Nebraska	1,296	584	186,579	124,417	49,157	42,225	23,110	19,010
Kansas	1,769	737	231,779	165,286	52,335	45,425	30,601	22,307
Montana	549	226	81,759	57,677	93,524	35,071	11,007	4,906
Wyoming	194	67	25,554	15,748	62,431	11,809	2,102	1,624
Colorado	940	266	98,842	59,934	66,341	24,462	7,745	5,261
New Mexico	360	161	54,046	29,844	78,402	24,410	1,717	1,812
Arizona	334	91	35,364	9,975	72,838	5,802	713	490
Utah	449	140	43,035	25,662	52,598	5,050	1,715	1,027
Nevada	77	16	8,431	3,163	70,285	2,357	595	396
Idaho	432	201	67,135	42,106	53,347	8,376	4,512	2,323
Washington	1,357	283	100,775	66,288	42,775	13,245	7,129	3,941
Oregon	783	214	78,753	50,206	61,188	13,542	4,914	2,805
California	3,427	517	259,709	117,670	99,617	29,366	11,878	5,920
United States	105,273	31,613	10,645,497	6,448,139	1,903,177	955,878	503,069	365,348

[1] District of Columbia omitted.

TABLE XV.—*Total number of farms, average number of crop-acres per farm, average number of workers per farm, average number of crop-acres per worker, average value of all crops per worker and per crop-acre, average value of machinery per farm and per worker, and average income per farm operator* [1]

State	Total number of farms [2]	Average crop-acres per farm [2]	Average number workers per farm [2]	Average crop-acres per worker [2]	Average value crops per worker [3]	Average value crops per crop-acre [3]	Average value machinery per farm [2]	Average value machinery per worker [2]	Average net income per farm operator [4]
	Farms	*Acres*	*Workers*	*Acres*					
Maine	48,227	34.12	1.27	26.92	$1,082	$41.70	$552	$436	$1,532
New Hampshire	20,523	26.52	1.24	21.40	938	43.80	463	374	811
Vermont	29,075	40.71	1.44	28.34	1,153	39.90	730	509	1,280
Massachusetts	32,001	20.36	1.60	12.74	1,117	87.80	605	379	913
Rhode Island	4,083	18.03	1.87	9.66	664	69.30	590	316	797
Connecticut	22,655	22.44	1.61	13.94	1,381	93.60	585	363	953
New York	193,195	45.42	1.58	28.76	1,166	40.50	879	557	1,807
New Jersey	29,702	37.27	1.96	19.06	1,194	65.30	857	438	1,736
Pennsylvania	202,250	41.99	1.36	30.79	1,137	38.80	810	594	1,482
Delaware	10,140	51.74	1.71	30.22	1,028	38.30	669	391	1,780
Maryland	47,908	44.76	1.89	23.68	890	39.50	605	320	1,379
Virginia	186,242	27.89	1.57	17.81	733	44.00	269	172	1,119
West Virginia	87,289	24.78	1.36	18.18	733	42.60	211	155	858
North Carolina	269,763	23.23	1.74	13.38	854	56.30	202	117	1,454
South Carolina	192,693	29.18	2.17	13.44	630	42.30	249	115	1,712
Georgia	310,732	38.65	1.94	19.96	501	27.40	204	105	1,338
Florida	54,005	33.31	1.99	16.76	698	55.20	251	126	915
Kentucky	270,626	25.34	1.45	17.51	677	42.50	179	123	968
Tennessee	252,774	28.56	1.56	18.26	583	32.10	212	135	962
Alabama	256,099	31.13	1.94	16.02	475	26.90	134	69	949
Mississippi	272,101	24.19	1.83	13.21	467	33.10	147	80	1,008
Louisiana	135,463	29.66	2.06	14.41	594	37.30	242	117	1,069
Arkansas	232,604	28.94	1.73	16.74	603	34.80	187	108	1,162
Texas	436,033	58.36	1.81	32.31	1,055	31.40	354	196	2,030
Oklahoma	191,988	79.90	1.63	49.01	991	20.70	420	258	2,227
Ohio	256,695	49.60	1.39	35.70	993	30.10	571	411	1,819
Indiana	205,126	60.76	1.42	42.77	979	23.80	621	437	1,834
Illinois	237,181	88.44	1.59	55.70	1,309	23.60	939	591	2,657
Michigan	196,447	49.37	1.38	35.74	1,002	29.00	623	451	1,539
Wisconsin	189,295	52.27	1.54	33.86	1,092	30.50	883	572	1,863
Minnesota	178,478	93.60	1.63	57.37	1,104	18.90	1,015	622	1,982
Iowa	213,439	99.03	1.52	65.23	1,549	23.10	1,449	954	2,985
Missouri	263,004	61.02	1.49	40.95	870	22.00	526	353	1,504
North Dakota	77,690	251.76	1.54	163.33	1,762	11.00	1,470	953	2,218
South Dakota	74,637	200.94	1.56	128.51	1,786	13.40	1,506	963	2,657
Nebraska	124,417	154.59	1.50	103.09	1,678	16.70	1,231	821	2,928
Kansas	165,286	134.91	1.40	96.21	1,575	16.20	936	668	2,417
Montana	57,677	67.27	1.42	47.46	1,096	13.40	954	673	137
Wyoming	15,748	75.29	1.62	46.40	1,278	19.70	748	461	1,493
Colorado	59,934	88.23	1.65	53.50	1,368	22,20	831	504	2,255
New Mexico	29,844	39.35	1.81	21.73	668	26.30	327	180	1,205
Arizona	9,975	46.62	3.55	13.15	979	64.40	884	249	3,133
Utah	25,662	41.55	1.68	24.78	888	33.20	527	314	1,875
Nevada	3,163	124.04	2.66	46.54	1,282	27.30	1,148	431	3,354
Idaho	42,106	66.31	1.59	41.59	1,353	32.10	912	572	2,192
Washington	66,288	63.86	1.52	42.01	1,696	38.30	826	543	2,490
Oregon	50,206	59.44	1.57	37.89	1,347	31.50	828	528	1,813
California	117,670	58.14	2.21	26.34	1,686	64.40	1,156	524	3,485
United States [1]	6,448,139	56.59	1.65	34.28	950	27.40	557	338	1,682

[1] Exclusive of District of Columbia.
[2] From 1920 census.
[3] 1919–1923 average, division of crop estimates, U. S. Department of Agriculture.
[4] National Bureau of Economic Research, Distribution of Income by States in 1919.

TABLE XVI.—*Farms classified by size*[1] *(1920 census)*

State	Percentage of all farms in State										Average acreage per farm	Average acreage of improved land per farm	Total farms
	Under 3 acres	3 to 9 acres	10 to 19 acres	20 to 49 acres	50 to 99 acres	100 to 174 acres	175 to 259 acres	260 to 499 acres	500 to 999 acres	1,000 acres and over			
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Acres*	*Acres*	*Number*
Maine	0.3	4.1	5.0	14.0	29.6	29.9	10.8	5.1	1.0	0.2	112.5	41.0	48,227
New Hampshire	.6	6.6	7.0	16.4	23.8	24.3	11.3	7.3	2.1	.7	126.9	34.2	20,523
Vermont	.3	6.0	5.3	10.1	17.9	30.2	17.5	10.7	1.9	.3	145.7	58.2	29,075
Massachusetts	2.7	13.7	13.3	23.5	21.4	15.3	5.7	3.3	.8	.3	77.9	28.4	32,001
Rhode Island	1.5	9.5	11.9	24.1	25.3	17.6	5.6	3.1	1.1	.3	81.2	32.5	4,083
Connecticut	.6	9.1	10.9	24.4	25.6	18.5	6.5	3.4	.7	.2	83.8	30.9	22,655
New York	.5	6.6	6.6	14.1	26.3	29.5	11.0	4.8	.5	.1	106.8	68.1	193,195
New Jersey	1.3	10.4	12.7	22.8	24.8	21.0	4.9	1.6	.3	.2	76.8	52.4	29,702
Pennsylvania	.5	7.4	7.8	18.0	30.7	26.1	6.6	2.3	.3	.1	87.3	58.6	202,250
Delaware	.2	4.7	7.1	21.5	29.1	24.8	8.5	3.5	.5	-----	93.1	64.4	10,140
Maryland	.4	9.2	10.2	18.8	21.8	23.3	10.1	5.3	.8	.1	99.3	65.5	47,908
Virginia	.2	7.6	11.8	24.6	22.9	18.3	7.5	5.2	1.5	.4	99.7	50.8	186,242
West Virginia	.2	5.1	6.6	20.8	29.3	22.4	8.6	5.1	1.4	.4	109.6	63.2	87,289
North Carolina	.1	4.9	14.0	32.3	25.5	15.2	4.6	2.5	.6	.2	74.2	30.4	269,763
South Carolina	.2	5.4	15.6	44.1	19.5	9.4	2.9	1.9	.7	.3	64.5	32.1	192,693
Georgia	.1	2.0	6.6	43.3	26.1	13.3	4.5	2.9	1.0	.4	81.9	42.0	310,732
Florida	.7	7.0	11.8	35.9	20.1	14.1	4.8	3.5	1.3	.7	112.0	42.5	54,005
Kentucky	.6	8.5	12.7	23.5	26.3	18.8	5.8	3.0	.6	.1	79.9	51.6	270,626
Tennessee	.1	4.8	12.7	31.6	25.7	16.3	5.2	2.8	.6	.2	77.2	44.3	252,774
Alabama	.1	3.5	9.6	44.1	22.4	12.7	3.9	2.6	.8	.3	76.4	38.6	256,099
Mississippi	.1	3.0	21.2	42.9	15.4	10.4	3.5	2.5	.7	.3	66.9	34.3	272,101
Louisiana	.3	3.0	18.9	45.3	16.0	9.5	3.1	2.4	.9	.6	74.0	41.5	135,463
Arkansas	.1	2.3	13.0	39.7	21.8	15.6	4.3	2.5	.5	.2	75.0	39.6	232,604
Texas	.2	1.6	4.1	25.3	27.4	22.2	7.4	6.3	2.9	2.6	261.5	71.6	436,033
Oklahoma	.1	1.0	2.1	17.0	22.6	34.5	8.5	11.1	2.4	.8	166.4	94.4	191,988
Ohio	.3	5.9	6.1	17.3	33.6	27.2	6.8	2.5	.3	-----	91.6	72.2	256,695
Indiana	.3	4.6	4.8	17.0	31.7	28.2	8.9	3.9	.4	.1	102.7	81.3	205,126
Illinois	.3	3.2	3.6	11.4	21.9	34.3	16.5	8.0	.7	.1	134.8	115.1	237,181
Michigan	.2	2.9	3.4	20.8	36.3	26.8	6.7	2.5	.3	.1	96.9	65.8	196,447
Wisconsin	.2	2.6	2.5	13.1	32.1	33.6	10.8	4.6	.5	.1	117.0	65.8	189,295
Minnesota	.2	1.6	1.7	7.9	18.3	36.9	17.4	14.1	1.7	.2	169.3	120.4	178,478
Iowa	.2	2.7	2.5	6.1	16.8	40.1	19.4	11.2	.9	.1	156.8	134.0	213,439
Missouri	.2	2.7	3.4	15.6	25.6	30.2	12.7	7.9	1.4	.2	132.2	94.4	263,004
North Dakota	-----	.2	.2	.7	1.2	14.8	7.2	47.0	23.7	5.1	466.1	316.2	77,690
South Dakota	.1	.5	.5	1.3	3.2	22.1	12.8	37.2	15.6	6.8	464.1	243.8	74,637
Nebraska	.1	1.3	1.3	3.0	9.0	34.7	17.3	20.8	7.8	4.8	339.4	185.7	124,417
Kansas	.2	2.3	2.0	5.0	12.3	29.7	16.1	22.7	7.3	2.5	274.8	185.1	165,286
Montana	.2	.7	.8	2.2	3.7	15.1	5.9	40.9	20.8	9.7	608.1	190.8	57,677
Wyoming	.4	.5	.4	2.5	6.3	16.2	5.9	32.3	22.4	13.2	749.9	133.5	15,748
Colorado	.7	3.8	3.7	7.4	9.9	20.3	6.7	29.4	12.5	5.7	408.1	129.2	59,934
New Mexico	1.3	12.5	8.9	10.4	6.7	16.5	3.9	19.6	10.7	9.4	817.9	57.5	29,844
Arizona	1.4	5.7	7.4	23.7	17.1	22.4	3.7	9.8	4.8	4.0	581.7	71.5	9,975
Utah	1.0	7.6	9.3	25.5	19.8	15.9	6.9	8.2	3.3	2.4	196.8	66.8	25,662
Nevada	1.1	3.9	3.3	13.8	17.5	19.3	7.2	13.4	9.0	11.5	745.2	188.0	3,163
Idaho	.8	2.8	3.3	16.2	20.2	25.1	8.7	16.2	5.2	1.4	198.9	107.2	42,106
Washington	1.4	9.9	12.9	23.0	13.6	15.0	5.0	9.5	6.1	3.4	199.8	107.6	66,288
Oregon	.8	6.1	8.1	17.4	16.5	19.4	8.0	12.5	6.7	4.4	269.7	97.9	50,206
California	2.5	11.7	14.8	27.0	12.8	11.2	4.5	7.1	4.3	4.2	249.6	100.9	117,670
United States	.3	4.2	7.9	23.3	22.9	22.5	8.2	7.4	2.3	1.0	148.2	78.0	6,448,139

[1] District of Columbia omitted.

TABLE XVII.—*Approximate percentage of labor and animal power devoted to each enterprise on different types of farms, as determined by records kept on a limited number of farms of each type*

Enterprise	Minnesota crop farms (21 farms) [1]		Minnesota dairy farms (23 farms) [1]		New York general farms [2]		Kentucky tobacco farms (14 farms) [1]		Kansas grain farms (18 farms) [1]		Montana grain farms (16 farms) [1]	
	Man	Horse	Man	Horse	Man	Horse	Man	Horse	Man	Horse	Man	Horse
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Crops	33.8	83.0	27.7	74.0	43.7	74.4	63.0	83.4	48.5	88.4	49.3	82.3
Livestock	52.7	9.5	58.1	9.4	40.8	8.8	22.9	6.9	35.5	7.5	33.2	9.5
Garden	1.3	.7	.2	.2	.4	.2	------	------	1.3	.8	1.5	1.0
Household	2.8	1.8	2.2	2.8	------	------	3.5	1.9	3.7	1.1	4.0	2.1
Real estate	5.5	3.2	3.6	2.4	7.8	5.6	6.0	3.9	7.4	2.0	7.0	3.8
Equipment	2.2	.5	2.4	1.1	1.4	.6	.7	.2	3.6	.2	2.6	.5
All else	1.7	1.3	5.8	10.1	5.9	10.4	3.9	3.7	------	------	2.4	.8

[1] Bureau of Agricultural Economics, U. S. Department of Agriculture.
[2] Cornell University Bulletin No. 414. (Number of farms on which report is based varied from 18 to 46 during different years over which records were kept.)

TABLE XVIII.—*Percentage of total year's farm work done each month, based upon estimates of county crop reporters of the Division of Crop and Livestock Estimates*

State	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Maine	0.8	0.8	2.2	7.5	16.5	16.7	15.7	10.8	15.8	8.5	3.5	1.2
New Hampshire	2.0	2.2	2.8	6.8	15.2	14.0	16.6	13.6	9.8	9.4	5.0	2.6
Vermont	1.7	1.6	3.5	6.5	15.7	12.3	17.5	14.5	10.0	10.0	4.2	2.5
Massachusetts	2.2	2.5	6.2	8.5	12.8	15.2	13.5	11.5	10.5	10.0	4.8	2.3
Rhode Island	2.3	2.3	5.7	12.7	15.0	10.0	9.3	7.7	13.3	11.0	5.7	5.0
Connecticut	4.0	4.0	5.0	8.5	11.5	12.3	14.3	10.2	10.5	9.2	6.5	4.0
New York	2.6	2.6	4.5	8.7	11.9	11.5	13.9	12.5	10.7	10.8	6.8	3.5
New Jersey	2.7	2.9	5.0	10.1	12.5	12.9	13.5	12.5	10.8	8.0	6.1	3.0
Pennsylvania	2.3	2.4	4.3	8.8	11.6	12.1	14.5	12.4	11.7	10.1	6.7	3.1
Delaware	2.3	2.7	3.3	9.0	11.3	14.0	16.8	10.3	11.3	11.0	5.0	3.0
Maryland	2.1	2.6	5.4	8.3	12.6	14.0	13.8	7.8	11.2	10.6	7.4	4.2
Virginia	2.4	3.0	5.9	10.1	12.2	14.9	13.2	8.2	10.9	9.1	6.3	3.8
West Virginia	1.7	3.4	8.0	11.7	13.2	13.8	13.7	9.6	9.8	7.7	4.7	2.7
North Carolina	2.7	3.5	6.8	10.1	12.2	15.6	11.5	7.4	8.4	10.0	7.8	4.0
South Carolina	3.0	4.1	8.0	11.3	13.3	14.2	8.9	5.4	8.3	11.1	8.9	3.5
Georgia	3.8	5.2	8.4	11.4	13.2	13.2	8.6	5.2	9.3	10.3	7.6	3.8
Florida	9.1	10.4	11.8	11.4	9.8	7.7	5.8	4.9	6.4	8.1	7.8	6.8
Kentucky	2.2	3.0	6.4	10.5	13.8	15.8	12.4	9.0	8.7	8.1	6.6	3.5
Tennessee	2.3	3.6	6.9	11.6	14.2	16.0	10.1	6.8	8.2	9.8	7.2	3.3
Alabama	3.1	5.1	9.0	12.7	14.4	14.4	7.8	4.1	6.7	11.1	7.4	4.2
Mississippi	2.7	4.1	9.0	12.1	13.1	13.7	10.2	5.9	7.3	10.3	8.2	3.4
Louisiana	3.6	7.0	11.0	13.1	11.7	10.6	5.8	5.3	8.0	11.4	8.5	4.0
Arkansas	2.6	3.6	8.5	12.5	13.7	14.5	8.9	5.8	7.7	10.4	7.8	4.0
Texas	4.0	5.4	8.4	9.9	12.1	12.3	8.1	6.5	10.6	11.3	7.4	4.0
Oklahoma	3.0	4.2	7.8	9.9	11.8	14.0	10.4	7.4	9.3	10.0	7.9	4.3
Ohio	2.5	2.8	5.2	9.1	11.5	12.7	14.8	11.3	10.8	8.9	6.6	3.8
Indiana	2.0	2.5	4.8	8.8	12.0	14.9	14.7	10.3	10.2	8.6	7.6	3.6
Illinois	2.0	2.5	5.2	9.0	12.5	13.5	14.2	10.8	9.4	8.7	8.6	3.6
Michigan	2.1	2.2	3.5	7.5	11.9	12.2	14.3	12.3	12.1	12.2	6.5	3.2
Wisconsin	2.5	2.6	3.7	9.5	12.5	11.7	15.1	13.7	12.0	8.7	4.9	3.1
Minnesota	2.6	2.8	4.5	10.5	10.9	9.9	12.1	14.9	13.5	10.3	5.3	2.7
Iowa	2.4	2.5	5.0	10.7	12.1	11.4	12.8	11.8	9.6	8.9	9.1	3.7
Missouri	2.5	3.5	6.9	10.3	13.0	14.2	12.8	8.0	9.2	8.3	7.4	3.9
North Dakota	2.4	2.5	4.0	10.2	13.8	8.0	10.0	14.8	14.8	10.7	5.6	3.2
South Dakota	2.4	2.7	4.9	10.8	12.1	10.6	11.5	14.1	10.5	9.2	7.2	4.0
Nebraska	2.5	2.5	4.8	8.1	10.7	12.1	14.3	13.2	10.4	9.2	8.0	4.2
Kansas	2.1	2.7	5.5	8.4	10.8	12.9	15.8	12.5	11.1	8.7	5.8	3.7
Montana	1.7	2.1	4.8	10.9	12.2	9.1	10.8	13.9	14.4	11.0	6.2	2.9
Wyoming	2.4	2.8	4.7	9.4	15.5	11.8	12.1	13.6	11.0	9.9	4.1	2.7
Colorado	1.7	2.0	4.5	9.7	13.2	9.8	10.3	14.5	12.7	12.3	6.3	3.0

TABLE XVIII.—*Percentage of total year's farm work done each month, based upon estimates of county crop reporters, etc.*—Continued

State	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
New Mexico	2.3	3.8	6.7	13.1	12.7	9.3	9.7	11.2	14.6	9.9	3.9	2.8
Arizona	3.5	4.5	4.8	10.7	15.7	14.2	10.8	5.8	11.8	8.7	5.8	3.7
Utah	1.7	1.6	4.9	10.9	16.4	10.0	12.2	12.4	13.8	8.7	5.0	2.4
Nevada	3.2	4.0	10.0	9.5	8.0	13.0	13.2	11.2	10.8	8.8	4.5	3.8
Idaho	1.2	1.5	5.1	11.1	12.4	11.3	13.0	14.7	13.0	9.4	5.5	1.8
Washington	2.1	3.3	8.3	11.7	12.0	9.5	10.7	12.5	12.0	10.7	4.6	2.6
Oregon	2.3	4.1	7.5	9.8	9.0	10.5	13.4	13.7	12.9	8.7	5.5	2.6
California	5.3	5.6	7.6	8.2	8.9	11.9	11.7	11.0	10.4	7.8	6.8	4.8
United States	2.8	3.7	6.8	10.4	12.6	13.1	11.3	8.9	9.8	9.9	7.1	3.6

TABLE XIX.—*Approximate average cost per horsepower-hour of animal labor in 1924* [1]

First cost of animal	$75.00
First cost of harness	30.00
Average drawbar horsepower-hours developed annually, 490.	
Annual interest on horse and harness, at 8 per cent	4.20
Annual depreciaton due to age, at 5 per cent	5.25
Housing, taxes, and insurance per year	10.00
Cost of feed and care not chargeable directly to work, at 16.5 cents per day	60.00
Total fixed charges per year	79.45
Credit for manure creditable to fixed charges	8.45
Net total fixed charges per year	71.00
Depreciation per horsepower-hour chargeable directly to use	.012
Cost of feed and care per horsepower-hour chargeable directly to use	.067
Cost of shoeing, veterinary, and harness repair per horsepower-hour	.012
Total operating cost per horsepower-hour developed	.091
Less credit for manure chargeable directly to work done	.007
Net operating cost per horsepower-hour developed	.084

Net cost per drawbar horsepower-hour and per year, including both operating and fixed charges for various amounts of power developed annually

Horsepower-hours developed annually per drawbar horsepower	Fixed charges per horsepower-hour	Operating charges per horsepower-hour	Total cost per horsepower-hour	Total cost per year per drawbar horsepower
100	$0.710	$0.084	$0.794	$79.40
200	.355	.084	.439	87.80
300	.237	.084	.321	96.30
400	.177	.084	.261	104.40
500	.142	.084	.226	113.00
600	.118	.084	.202	121.20
700	.101	.084	.185	129.50
800	.089	.084	.173	138.40
1,000	.071	.084	.155	155.00

[1] Does not include wages of driver when horses are in use, but does include wages for time required for care of horse when not actually at work. Wages for the driver were excluded in these computations because they vary indirectly with the size of unit used and also because in some operations much of the attention of the operator is devoted to manipulating the machinery used rather than caring for the power unit.

TABLE XX.—*Approximate average cost per drawbar horsepower-hour for gas tractor power in 1924* [1]

First cost per drawbar horsepower	$75.00
Average equivalent drawbar horsepower-hours, developed annually, 265.	
Annual interest at 8 per cent on average investment	3.20
Annual depreciation and repair charge due to age at 8 per cent	6.00
Housing, taxes, and insurance per year	2.00
Total fixed charges per year per drawbar horsepower	11.20
Depreciation per horsepower-hour chargeable to use	.023
Cost of fuel, oil, and care per horsepower-hour	.041
Cost of repairs and labor per horsepower-hour	.019
Total operating costs per drawbar horsepower	.083

Net cost per drawbar horsepower-hour and per year, including both operating and fixed charges for various amounts of power developed annually

Horsepower-hours developed annually per drawbar horsepower	Fixed charges per horsepower-hour	Operating charges per horsepower-hour	Total cost per horsepower-hour	Total cost per year per drawbar horsepower
50	$0.224	$0.083	$0.307	$15.35
100	.112	.083	.195	19.50
200	.056	.083	.139	27.80
300	.037	.083	.120	36.00
400	.028	.083	.111	44.40
500	.022	.083	.105	52.50
600	.019	.083	.102	61.20
700	.016	.083	.099	69.30
800	.014	.083	.097	77.60
1,000	.011	.083	.094	94.00
2,000	.006	.083	.089	178.00
3,000	.004	.083	.087	261.00

[1] Does not include wages for operator while tractor is in use, but does include an allowance for care and for time required in putting in fuel and for greasing.

Wages for the operator were excluded in these computations because they vary indirectly with the size of unit used and also because in some operations much of the time of the operator is devoted to manipulating the machinery used rather than caring for the power unit.

TABLE XXI.—*Average weight of horses and mules and estimated horsepower-hours developed annually per average work animal*

State	Average weight of horses [1]	Average weight of mules [1]	Horsepower-hours per average work animal [2]	State	Average weight of horses [1]	Average weight of mules [1]	Horsepower-hours per average work animal [2]
	Pounds	*Pounds*	*Horsepower*		*Pounds*	*Pounds*	*Horsepower*
Maine	1,325	1,050	630	Ohio	1,310	1,040	570
New Hampshire	1,270	1,050	600	Indiana	1,255	1,040	530
Vermont	1,200	1,000	550	Illinois	1,270	1,050	550
Massachusetts	1,255	1,040	550	Michigan	1,295	1,040	590
Rhode Island	1,290	1,020	500	Wisconsin	1,300	1,025	590
Connecticut	1,220	1,040	570	Minnesota	1,305	1,035	550
New York	1,180	995	540	Iowa	1,320	1,050	570
New Jersey	1,220	1,010	530	Missouri	1,130	1,015	450
Pennsylvania	1,210	1,000	500	North Dakota	1,290	1,040	480
Delaware	1,080	920	480	South Dakota	1,245	1,010	470
Maryland	1,150	995	500	Nebraska	1,255	1,040	490
Virginia	1,100	950	490	Kansas	1,220	1,040	450
West Virginia	1,165	950	520	Montana	1,290	1,010	400
North Carolina	980	880	400	Wyoming	1,290	1,080	340
South Carolina	950	925	420	Colorado	1,230	1,050	430
Georgia	940	970	460	New Mexico	1,030	920	190
Florida	850	970	420	Arizona	1,150	970	180
Kentucky	1,010	950	420	Utah	1,270	1,020	420
Tennessee	990	890	400	Nevada	1,200	980	330
Alabama	895	895	360	Idaho	1,270	1,050	480
Mississippi	870	865	360	Washington	1,350	1,110	670
Louisiana	900	940	380	Oregon	1,310	1,100	600
Arkansas	960	890	370	California	1,285	1,065	620
Texas	1,000	930	360				
Oklahoma	1,080	960	400	United States	1,203	956	465

[1] Table 306, Yearbook, Department of Agriculture, 1918.
[2] Estimated from farm management data and all other available sources.

TABLE XXII.—*Estimated farm tonnage hauled annually* [1]

	Tons
HAULED TO MARKET	
Field crops:	
Corn	15,519,000
Wheat	22,407,000
Oats	5,108,000
Barley	1,666,000
Rye	1,984,000
Buckwheat	344,000
Rice	559,000
Flax	269,000
Potatoes—	
White	6,444,000
Sweet	2,779,000
Hay and seed	14,850,000
Cotton and seed	7,559,000
Tobacco	687,000
Beans	380,000
Cowpeas	267,000
Broomcorn	44,000
Grain sorghums	2,803,000
Peanuts	411,000
Hops	14,000
Sugar beets	6,266,000
Fruit and truck crops	8,457,000
Animal products:	
Milk	10,750,000
Cream	348,000
Butter	104,000
Cheese	3,000
Wool and mohair	117,500
Honey and wax	27,500
Eggs	758,000
Animal products—Contd.	
Poultry	211,000
Meat	337,000
Cattle	10,785,000
Swine	4,767,000
Sheep	556,000
Cordwood	38,717,000
Miscellaneous	20,000,000
Total hauled to market	186,298,000
HAULED FROM MARKET	
Grain and mill feed	21,946,000
Commercial fertilizer	6,458,000
Lime and ground limestone	1,522,000
Machinery and building supplies	2,000,000
Fuel purchased	8,000,000
Food and miscellaneous	10,000,000
Total	49,926,000
HAULED ABOUT FARM	
Field crops	269,154,000
Straw and roughage	253,239,000
Truck and fruit crops	9,855,000
Manure and fertilizer	250,000,000
Wood and fuel	150,000,000
Miscellaneous	50,000,000
Total	982,248,000

[1] Based on 1920 census figures.

TABLE XXIII.—*Estimated average tonnage hauled per farm per year*

Area	Average tonnage per farm [1]			Average distance to market [2]		Estimated average haul about farm [3]
	To market	From market	About farm	Wagon	Truck	
	Tons	*Tons*	*Tons*	*Miles*	*Miles*	*Miles*
New England	33	16	150	7.2	10.0	0.24
Middle Atlantic	32	14	175	7.6	12.2	.24
East North Central	32	9	210	6.3	9.3	.26
West North Central	40	10	244	7.9	10.1	.45
South Atlantic	19	8	81	8.4	9.8	.24
East South Central	13	3	79	10.4	12.9	.21
West South Central	23	5	91	10.9	13.0	.32
Mountain	60	9	184	20.2	21.0	.52
Pacific	69	13	123	11.2	12.3	.39
United States	29	8	152	9.0	11.3	.33

[1] Based on 1920 census figures.
[2] Yearbook, Department of Agriculture, 1921, p. 791.
[3] Estimated from average size of farms.

TABLE XXIV.—*Pounds pull exerted per drawbar horsepower for various speeds of travel*

Miles per hour	Feet per minute	Feet per second	Pull exerted per drawbar horsepower	Miles per hour	Feet per minute	Feet per second	Pull exerted per drawbar horsepower
			Pounds				*Pounds*
0.5	44	0.73	750.00	5.0	440	7.33	75.00
1.0	88	1.47	375.00	10.0	880	14.67	37.50
1.5	132	2.20	250.00	20.0	1,760	29.33	18.75
2.0	176	2.93	187.50	30.0	2,640	44.00	12.50
2.5	220	3.67	150.00	40.0	3,520	58.67	9.38
3.0	264	4.40	125.00	50.0	4,400	73.33	7.50
3.5	308	5.13	107.14	60.0	5,280	88.00	6.25
4.0	352	5.87	93.75				

APPENDIX II

SELECTED BIBLIOGRAPHY

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413. Influence of age on the value of farm work horses.
423. Labor requirements of dairy farms as influenced by milking machines.
511. Farm practice in the cultivation of cotton.
560. Cost of keeping farm horses and cost of horse labor.
578. A study of haymaking crews and labor costs.
627. Cost of harvesting wheat by different methods.
757. Farm practices in grain growing in North Dakota.
814. The standard day's work in central Illinois.
853. The organization and management of farms in northwestern Pennsylvania.
910. Experience of Eastern farmers with motor trucks.
917. Farm practice in growing field crops in three sugar-beet districts of Colorado.
920. Farm profits.
931. Corn belt farmers' experience with motor trucks.
943. Cost of producing wheat.
961. Standards of labor on the hill farms of Louisiana.
963. Cost of producing sugar beets in Utah and Idaho, 1918–19.
995. The beet-sugar industry in the United States in 1920.
997. The cost and utilization of power on farms where tractors are owned.
1000. Labor and material requirements of field crops.
1034. Farm management and farm organization in Sumter County, Ga.
1181. Labor requirements of Arkansas crops.
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212. The manufacture and sale of farm equipment in 1920.
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838. Harvesting hay with the sweep-rake.
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1289. Distribution of types of farming in the United States.
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Farmers' Bulletins—Continued.
1296. Changes effected by tractors on Corn Belt farms.
1297. Cost of using tractors on Corn Belt farms.
1298. Cost of using horses on Corn Belt farms.
1299. Shall I buy a tractor?
1300. Choosing a tractor.
1314. Motor trucks on Corn Belt farms.

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SMITHSONIAN INSTITUTION PUBLICATIONS

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Energy resources of the United States.
Power: Its significance and needs.

STATE PUBLICATIONS

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Circular 46. Tractor situation in Alabama.
California:
Bulletin 349. A study of side-draft and tractor hitches.
Florida:
Circular 12. Tractors in Florida.
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Illinois:
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Bulletin 231. The horse and the tractor.
Bulletin 238. Feeding farm work horses and mules.
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Indiana:
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